Appearance of malignant breast lesions identified with Digital Breast Tomosynthesis

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Authors: P. Clauser¹, A. De Nicolò¹, V. Londero², C. Zuiani², M. Bazzocchi², C. Molinari²; ¹Udine, Italy/IT, ²Udine/IT
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**Learning objectives**

To illustrate the semeiology of malignant breast lesions in Digital Breast Tomosynthesis (DBT).

We first reviewed the technical aspects of DBT and the appearance of malignant lesions according to ACR BIRADS classification [1]. Our aim was to evaluate the usefulness of classical mammography semeiology as described in literature [1,2] in Tomosynthesis images, and to underline possible adjunctive findings suggestive for malignancy.

**Background**

Digital Breast Tomosynthesis is a technique that uses conventional x-rays and a digital detector to obtain a variable number of images from the acquisition of multiple low-dose projections of the breast. The reconstructed images show a plane of the breast in sharp focus, while tissue above and below appears out of focus [3,4].

Various vendors are undergoing clinical trials, but up to now there is no universally accepted technology.

General characteristics of a DBT unit are:

- the presence of a moving x-ray source with an arc-like motion. Different angular range and a continuous or step-and-shoot acquisition may be used;

- a flat-panel digital detector, that may consist of selenium, which is usually preferred, or of cesium iodide crystal on an amorphous silicon layer. The detector may be stationary or move with the tube;

- reconstruction algorithms, similar to those of CT, to reconstruct images from the data obtained [5].

The dose of a single DBT acquisition is reported to be approximately equal to that of a two view Digital Mammography, but new technologies may help reduce the radiation exposure.

The aim of introducing DBT in clinical practice, as stated by more than one study already published [3,5], is to reduce diagnostic doubts (false negative and false positive) related to superimposition of glandular tissue, particularly in women with dense breasts. Up to now, the majority of articles regarding Tomosynthesis concentrated on technical and physical aspects or on the performance of this new technique compared to Digital Mammography.
There is a general consensus in the application of ACR BIRADS in description of breast findings [1], but some typical aspect must be considered.

**Imaging findings OR Procedure details**

*Technique*

We used a digital system to obtain both mammography and tomosynthesis images (Giotto TOMO, IMS, Bologna, Italy; Fig. 1). The unit acquires 13 projections with a low dose protocol on a ±20° angular range; detector is stationary. Other technical aspects are:

- W-target X-ray source;
- a-Se digital detector (ANRAD, LMAM) with a sensitive area 24x30 cm² and squared pixel pitch 0.085 mm;
- Iterative reconstruction algorythm
- Reconstructed voxel size: 0.085 mm×0.085 mm×1.0 mm

Exposure parameters are determined by Automatic Exposure Control (AEC). AEC for DBT in one view was defined so as to deliver a radiation dose approximately 1.4 times that for digital mammography in one view.

Breast compression applied for DBT was less than for DM. All patients underwent DBT both in cranio-caudal and in medio-lateral oblique view.

*Patients*

Between May 2012 and November 2012, 26 women with 31 malignant lesions identified by Digital Mammography or US and characterized with percutaneous needle-biopsy underwent DBT before surgery. Mean age was 60.6 years (range 40-80 years).

Breast density according to ACR classification system was:

| BIRADS 1 | 6 patients |
| BIRADS 2 | 6 patients |
| BIRADS 3 | 12 patients |
| BIRADS 4 | 2 patients |
The 31 malignant lesions were:
- 2 high grade DCIS;
- 2 microinvasive ductal carcinoma, 1 with DCIS;
- 5 IDC grade 1; 2 with DCIS;
- 13 IDC grade 2, 2 with DCIS;
- 5 IDC grade 3, 1 with DCIS;
- 3 ILC grade 2;
- 1 ILC grade 2 with DCIS.

Lesion characterization

Findings suspicious for malignancy are usually classified as BIRADS 4 or 5. They can be masses or microcalcifications. Malignant masses are generally characterized by:
- Shape: oval, round, lobular or irregular;
- Margins: well defined, indistinct, spiculated;
- Density: high, equal or low compared to parenchyma.

Suspicious microcalcifications are identified by:
- Appearance: amorphous, pleomorphic or linear-branching;
- Distribution: cluster, linear or segmental.

Table 1 summarizes lesion appearance.

Lesions margins could be clearly delineated in all cases:

<table>
<thead>
<tr>
<th>Margins</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Well defined</td>
<td>1</td>
</tr>
<tr>
<td>Indistinct</td>
<td>6</td>
</tr>
<tr>
<td>Spiculated</td>
<td>9</td>
</tr>
</tbody>
</table>

Density was higher than surrounding tissue for almost all lesions:
Density

<table>
<thead>
<tr>
<th>Density</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>11</td>
</tr>
<tr>
<td>Equal</td>
<td>5</td>
</tr>
<tr>
<td>Low</td>
<td>0</td>
</tr>
</tbody>
</table>

Thus, the shape of the lesion could be clearly identified:

Shape

<table>
<thead>
<tr>
<th>Shape</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oval/Round</td>
<td>5</td>
</tr>
<tr>
<td>Lobular</td>
<td>2</td>
</tr>
<tr>
<td>Irregular</td>
<td>9</td>
</tr>
</tbody>
</table>

The high contrast between normal breast tissue and tumour can easily be recognized due to less tissue overlapping (Fig 2). Often this difference in density creates a translucent halo around the lesion that makes both mass margins and spicules easier to identify (Fig 3). Spicules and architectural distortions can be easily distinguished from normal breast (Fig 4).

As in 2D-Mammography, malignant masses present more often microlobulated or spiculated margins.

At the same time, morphology of microcalcifications (usually linear or heterogeneous when malignant) can appear more evident (Fig 5). The artefacts associated with calcifications are more often encountered for macrocalcifications, usually benign, and seem to be partially solved with the use of specific reconstruction algorithms [6]. We didn't detect significant artefacts associated with microcalcifications (Fig 6).

Tomosynthesis shows some limits in the evaluation of their distribution: sometimes, only one or two microcalcifications may be seen on a slice and so the perception of a cluster can become difficult. Overcome this limitation could be possible with the use of Maximum Intensity Projection (MIP) reconstructions [7] or with use of devices developed by various vendors, such as synthetic reconstruction of 2D-images or the acquisition of low-dose mammography in the central projections during DBT acquisition.

Scrolling the multiple images could also help recognizing normal anatomy, microcalcifications distribution and evaluating the presence of a circumscribed lesion.

The possibility of a quasi-3D imaging can help in the visualization of normal breast anatomy, both of the glandular tissue and of the vessels. It must be considered that the appearance of this structure is quite different from that of Digital Mammography, and so
even radiologists already experienced in breast imaging and 2D-Mammography need an adequate training period.

**Images for this section:**
Fig. 1: The Tomosynthesis device present at our Institution (TOMO, IMS, Bologna, Italy).

Table 1: Lesion appearance

Fig. 2: Both 2D-Mammography (left) and DBT (right) detect an area of increased density in a 68 y.o. woman. Margins and spiculae are better defined by DBT. After surgery the final diagnosis was grade 2 invasive ductal carcinoma.
Fig. 3: The high density of the lesion compared to surrounding parenchima creates a radiolucent halo that helps in defining margins and lesion itself (IDC gr 2 with DCIS).
**Fig. 4:** Distortion of breast tissue can be more evident at DBT (on the right). In this case in the area of architectural distortion was identified in a 62 y.o. woman; histology showed an invasive lobular carcinoma gr 2.
Fig. 5: DBT (on the right) can better define microcalcifications, especially their morphology. In this case of a 66 y.o. woman, microcalcifications were more evident with DBT. Diagnosis after needle-biopsy and surgery was invasive ductal carcinoma with an in situ component.
Fig. 6: Coarse calcifications or metallic markers often create a characteristic artefact, consisting in multiple repeating out-of-plane ghost images, flanked by dark regions.
Conclusion

Mammography semiology already described and classified by ACR can be used also for DBT. Tomosynthesis differs from mammography regarding:

- the better identification of lesion shape and margins, due to the higher contrast compared to breast parenchima;

- the difficulty, in some cases, in defining the distribution of microcalcification, when present on more than one slice.

References


Personal Information