Breast imaging training: radiology residents' performance in digital mammography (DM) interpretation implemented by digital breast tomosynthesis (DBT)

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Aims and objectives

Breast radiological training during the radiology residency consists in gaining basic skills and knowledge in breast imaging, which should allow residents to function independently as radiologists involved in all aspects of breast diagnosis. In literature some studies [1-3] have shown a lack of interest of radiology residents in this ambit mainly because of the risk of malpractice. Therefore an appropriate training is increasingly request to improve competence of future breast imagers with the purpose to create dedicated radiologists in the field of breast cancer [4].

At our institution, during the breast imaging residency training, each resident is required, both with theoretical lessons and clinical practice, to acquire competence about:

- radiology of the normal breast and variants of normal;
- the radiology of benign and malignant breast disease with the differential diagnosis between mass lesions, microcalcifications and parenchyma distortion;
- breast imaging reporting and data system (BI-RADS classification[5]);
- basic imaging techniques including digital mammography (DM) and ultrasound and additional techniques, including magnetic resonance and digital breast tomosynthesis (DBT);
- biopsy techniques;
- the importance of radiological-pathological correlation;
- current issues of breast diagnosis and treatment.

The purpose of our study was to evaluate if a different period of training could influence the diagnostic accuracy, the sensitivity, the specificity and the positive (PPV) and negative (NPV) predictive value of a group of radiology residents with different experience in breast imaging.

We also analysed if the digital breast tomosynthesis as an adjunct to digital mammography may improve their diagnostic performances compared to digital mammography alone. Indeed several studies [6-14] have demonstrated the improvement in radiologists’ performances in reading digital mammograms with the addition of DBT, but currently, at our knowledge, there is not any study analysing the eventual improvement offered by this emerging breast imaging technology in diagnostic performances of inexperienced or less experienced readers, as residents might be.
Methods and materials

Seven radiology residents (3/7 1st-year postgraduate and 4/7 2nd-year postgraduate residents) with different experience (from 6 months to 12 months) in breast imaging were enrolled for a multi-reader observer study; 4/7 readers were performing the breast radiological training at the moment of the study, 3 of which with an experience of 9 months or more and one with a 6 months' experience, whereas 3/7 residents had already finished their rotation at breast imaging unit (experience of about 12 months) (table 1).

During their rotation, residents interpreted about 400 mammography cases per month (both DM alone and DM+DBT) under supervision.

Residents have also followed a theoretical course and lectures about the basic knowledge in breast imaging.

The study was based on a set of 78 digital mammograms, selected by 2 dedicated breast radiologists, as random samples between the patient population who underwent mammography examination at the Breast Imaging Unit of the Azienda Ospedaliera Città della Salute e della Scienza of Turin (Presidio San Giovanni Battista) from January 2010 to January 2011.

Each patient, after signed an informed consent, underwent a bilateral mammography, performed with a FFDM unit with integrated tomosynthesis acquisition (Hologic Selenia Dimensions, Hologic, Bedford, MA). Bilateral two views (cranio-caudal and medio-lateral oblique) were obtained in Combo mode: hence DM and DBT images were acquired with a single breast compression for each projection. DBT images were viewed as 1 mm reconstructed sections.

30/78 cases (containing 35 malignant lesions) were proven to have cancer at histology, 13/78 cases were benign at biopsies and 35/78 were healthy (with a negative follow-up at 1 year). Breast cancer cases were chosen on the basis of subtle signs on DM.

Each reader, blinded to clinical information, comparison examinations and histology, interpreted subsequently at first the DM images alone and, after a month, the same cases, presented in a different order, using DBT images in conjunction with DM images. They were asked, without a limit of viewing time, to fill out a form reporting the presence, localization, dimensions and BI-RADS classification of suspicious mammographic findings. Two experienced radiologists, non-participants in the study, compared the results of each reader to pathology.

A statistical analysis was performed to evaluate sensitivity, specificity, diagnostic accuracy, positive (PPV) and negative (NPV) predictive value for each reader according to imaging modality.
The analysis was also performed using receiver operative characteristic (ROC) methods to assess and compare the diagnostic accuracy of the two imaging methods by calculating the area under the curve (AUC).

Comparisons were carried out using the chi-square test applied to cross-correlation tables; for 2x2 tables we used Yates correction. Statistical significance was set at p<0.05.
Table 1: The table summarizes the information pertaining to the seven residents (R1-R7) participating in the study.

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<table>
<thead>
<tr>
<th></th>
<th>POST-GRADUATE YEAR</th>
<th>EXPERIENCE IN BREAST IMAGING [months]</th>
<th>BREAST IMAGING ROTATION AT THE MOMENT OF THE STUDY</th>
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<tr>
<td>R1</td>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>R6</td>
<td>2nd</td>
<td>12</td>
<td>no</td>
</tr>
<tr>
<td>R7</td>
<td>2nd</td>
<td>11</td>
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</tr>
</tbody>
</table>


**Results**

Considering the diagnostic parameters of each reader (figures 1 and 2), sensitivity ranged from 48.6% to 85.7% for DM and from 60% to 94.3% for DM+DBT, specificity respectively from 62.8% to 88.1% and from 69.4% to 93.2%, PPV from 44.2% to 70.8% and from 58.7% to 85.3% and NPV from 74.3% to 92.5% and from 79.1% to 97.1%.

Considering the overall performances of the residents (figure 3), there was a total improvement of the values of all the diagnostic parameters by reading of DM with the implementation of Tomosynthesis compared to DM alone but it was not statistically significant.

The diagnostic accuracy for each reader was also evaluated by using ROC curve and by calculating the AUC for both modalities (table 2, figure 4).

Each resident has showed an improvement (ranging from 3% to 14%) in the diagnostic performance by using DM with the implementation of Tomosynthesis, but there was not a statistically significant difference for each reader between the two imaging modalities.

It has been demonstrated that the reader with the less experience (R5) had the worst performance (p<0.005) for both modalities compared to the other readers.

Evaluating the overall improvement of all the performances, it has been demonstrated a statistically significant difference (figure 5 and 6).
Fig. 1: Histogram showing the diagnostic parameters of each resident (R1-R7) in the reading of DM images alone.

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Fig. 2: Histogram showing the diagnostic parameters of each resident (R1-R7) in the reading of DM integrated by DBT.

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**Fig. 3:** Histogram showing the complexive values of diagnostic parameters for the 2 different modalities.

Table 2: The table summarizes the diagnostic accuracy of each reader (R1-R7) for both modalities obtained by calculating the AUC. It shows a general improvement of diagnostic accuracy with the addiction of DBT at the reading of DM for each resident (range from 3% to 14%).

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Fig. 4: Values of AUC for each reader (R1-R7) for both modalities show an improvement in diagnostic performance for every resident but with a not statistically significant difference.

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**Fig. 5:** ROC curves for the 2 modalities show a complexive improvement (p<0.05) in the diagnostic performances in reading DM with the implementation of DBT.

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Fig. 6: 36-year-old woman with family history of breast cancer: digital mammography bilateral two standard views ("back-to-back") [a) and b) crano-caudal and c) and d) medio-lateral oblique views] show an extremely dense breast tissue with subtle spiculated mass in the outer quadrant, at the 3:00 o'clock axis of the left breast. Tomosynthesis frames [crano-caudal e) and medio-lateral oblique f) views] of the left breast clearly demonstrate the spiculated mass much more evident (orange boxes) than that one shown by DM image alone. The mass was a biopsy proven 18 mm invasive ductal carcinoma. Only one reader (R7) was able to correctly identify this subtle lesion as suspicious for malignancy (BI-RADS 4) by using DM images alone. Whereas all the readers correctly identify the lesion suspicious for malignancy at the 2nd reading with the implementation of DBT.

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Conclusion

Our study attempts to address the current needs in breast imaging education and to propose the possibility to check the knowledge and skill of residents during their breast imaging practice.

Our results suggest that not only experience, but also clinical practice and personal skills and attitudes might influence diagnostic performances of radiology residents during their breast imaging training. Indeed, a different breast radiology experience between 6 months and 12 months does not reveal significant differences in sensitivity, specificity, PPV and NPV in reading DM images alone and DM+DBT for the seven readers. It also seems to be not important the age of course of the postgraduate school.

It is instead important (statistically significant value) in the comparison of diagnostic accuracy for both modalities.

The addition of DBT to DM increases all the diagnostic parameters of the readers; there is a significant overall improvement in interpretation of suspicious findings with the implementation of DBT, showing that also in inexpert readers this new technology could be useful in upgrading their diagnostic performances, above all considering specificity.
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