Preoperative breast cancer tumor size assessment. 
Comparison of mammography, tomosynthesis, ultrasound 
and magnetic resonance imaging in a multidisciplinary 
breast center

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Aims and objectives

Tumor size assessment is an essential data to design an optimal treatment planning for breast cancer. In the context of multidisciplinary breast units, this information guides surgical approach, systemic therapy (neoadjuvant treatment) and constitutes a prognostic factor. Clinical breast examination and imaging techniques (digital mammography, digital breast tomosynthesis (DBT), ultrasound (US) and MRI) have been used to estimate tumor extent. Despite its value at breast cancer screening, mammography is less accurate than tomosynthesis in determining breast size\(^1,2\) (the advantage of avoiding superimposition of tissue and a better characterization of the lesions could explain this fact). According to the literature, there is evidence in favor of MRI as a better tool to assess tumor extension\(^3,4\) even though preoperative MRI for staging would not reduce the risk of recurrence\(^5\). Depending on the report, it seems that US and MRI\(^6\) or DBT and MRI\(^7\) have better correlation with the pathologic size (however a study reports that ultrasound underestimates tumor size\(^8\)). The aim of our study was to compare the accuracy of preoperative tumor size measurements obtained on mammography, DBT, US and MRI with the pathologic tumor size.
Methods and materials

We performed a retrospective review of records from patients with the diagnosis of breast cancer that were evaluated by digital mammography and DBT as initial approach between May 2011 and December 2015 in our centre. This group of patients was assessed with other imaging modalities (ultrasound and MRI) as part of our standard staging protocol. Patients who had undergone neoadjuvant chemotherapy were excluded. A total of 293 patients met these criteria (the age range of the patients was from 31 to 88 years, 197 patients of our series were recalled from the breast cancer screening program and the remaining patients had symptoms or had periodic surveillance in our centre).

After signing the informed consent, each patient underwent bilateral two view cranio-caudal and medio-lateral-oblique digital mammography and DBT with the Hologic Selenia Dimensions system (images were acquired during the same compression for each view, in some cases we obtained lateral views), then a dedicated ultrasound examination of both breasts was performed the same day (with a high frequency probe ranging from 8mHz to 12mHz). MRI images were obtained posteriorly (after 1 to 3 weeks) and acquired with a 1.5T MRI scanner. Our protocol included diffusion-weighted imaging, T2-weighted sequence and a dynamic phase performed with a 3D T1-weighted gradient recalled echo before and after intravenous gadolinium injection (lesion’s morphology and enhancement parameters were assessed).

Images were part of a database reviewed independently by 3 radiologists with experience varying from 2 to 15 years, they recorded the measurement of the lesions during the diagnostic process (mammographic images first followed by DBT, US and MRI images) without knowing the pathologic measurements. In each imaging modality, the longest tumoral diameter was measured to the nearest millimeter. In all of our cases the diagnosis of breast cancer was confirmed by percutaneous biopsy or surgical exeresis. We compared tumor sizes reported by digital mammography, DBT, ultrasound and MRI with the final pathologic examination. Accuracies and differences were analyzed.
Results

We found 293 lesions in our cohort of patients, invasive ductal carcinoma was the most frequent pathologic diagnosis (233 cases), the remaining types (60 cases) accounted for 20.5% of the total of breast cancers Fig. 1 on page 7.

In terms of breast density, type b was the most frequent (59.7%) in our series, followed by type c (19.1%), a (15.7%) and d (5.5%) Fig. 2 on page 7.

Regarding the findings, we found six types of lesions with the different imaging modalities: Masses (86%), distortions (6.5%), microcalcifications (5.5%), asymmetries (1.7%) and a segmental enhancement visible only at MRI Fig. 3 on page 8.

We had different detection rates for each imaging modality, DBT had the highest detection rate (99.32%), MRI and digital mammography had high values (98.48% and 93.17%), US had the lowest rate (82.5%) Table 1 on page 13. MRI was not performed in 30 patients (lesions were occult in 4 patients in this modality). We didn't find measurement records by US in one case Fig. 4 on page 8.

The results at comparing the final pathological size with the sizes obtained with the different imaging modalities were as follows Table 2 on page 14:

- There was a significant difference (p<0.0001) with the size measured by digital mammography (the mean difference was 1.6 mm in favor of mammography).
- There was a significant difference (p<0.0001) with the size measured by DBT (the mean difference was 2 mm in favor of the surgical specimen).
- There was a significant difference (p<0.0001) with the size measured by ultrasound (the mean difference was 3.8 mm in favor of the surgical specimen).
- There was a significant difference (p<0.0001) with the size measured by MRI (the mean difference was 1.6 mm in favor of the surgical specimen).

The correlations of maximum tumor diameter measurements between the imaging modalities described and the surgical specimen were as follows (comparative analysis has been done by Pearson's correlation coefficient (r)):

- Pearson's correlation coefficient (PCC) of MRI and the final pathological size was 0.857, p<0.001 Fig. 5 on page 9
- The PCC of DBT and the final pathological size was 0.762, p<0.0001 Fig. 6 on page 10
• The PCC of US and the final pathological size was 0.727, $p<0.0001$. Fig. 7 on page 11
• The PCC of mammography and the final pathological size was 0.61, $p<0.0001$. Fig. 8 on page 12
Fig. 1: Histological types of breast cancer in our series.

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Fig. 2: Distribution of breast density.
Fig. 3: Distribution of findings in our series.
**Fig. 4:** Detection of lesions by imaging modality.

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**Fig. 5:** Scatterplots and Pearson's correlation coefficients (PCC) of maximum tumor diameter measurements between MRI and final pathological size.

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**Fig. 6:** Scatterplots and Pearson's correlation coefficients (PCC) of maximum tumor diameter measurements between tomosynthesis and final pathological size.

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Fig. 7: Scatterplots and Pearson's correlation coefficients (PCC) of maximum tumor diameter measurements between ultrasound and final pathological size.

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Fig. 8: Scatterplots and Pearson's correlation coefficients (PCC) of maximum tumor diameter measurements between mammography and final pathological size.

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Table 1: Number of identifiable lesions and detection rates by modality.

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<table>
<thead>
<tr>
<th></th>
<th>DM</th>
<th>DBT</th>
<th>US</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified</td>
<td>273</td>
<td>291</td>
<td>241</td>
<td>259</td>
</tr>
<tr>
<td>Not identified</td>
<td>20</td>
<td>2</td>
<td>51</td>
<td>4</td>
</tr>
<tr>
<td>Not performed/Not registered</td>
<td>1</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>293</td>
<td>293</td>
<td>293</td>
<td>293</td>
</tr>
<tr>
<td>Detection Rate (%)</td>
<td>93.2</td>
<td>99.3</td>
<td>82.53</td>
<td>98.5</td>
</tr>
</tbody>
</table>

Table 2: Comparison of the mean tumor size with the mean sizes obtained with the different imaging modalities.

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<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
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</thead>
<tbody>
<tr>
<td>Final pathological size</td>
<td>293</td>
<td>18.1</td>
<td>14.7</td>
<td>0-120</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Mammographic size</td>
<td>273</td>
<td>19.6</td>
<td>10.4</td>
<td>5-76</td>
<td>13</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>DBT size</td>
<td>291</td>
<td>18.2</td>
<td>10.6</td>
<td>5-75</td>
<td>12</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>US size</td>
<td>241</td>
<td>14.7</td>
<td>8</td>
<td>5-60</td>
<td>10</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>MRI size</td>
<td>259</td>
<td>19.5</td>
<td>12.9</td>
<td>4-90</td>
<td>12</td>
<td>16</td>
<td>22</td>
</tr>
</tbody>
</table>
Conclusion

In our study, mean mammographic size overestimated the mean tumor size, the rest of the imaging modalities underestimated it. Regarding detection rates in our breast cancer cases, MRI didn’t have the highest value (probably because in 30 patients MRI was not performed or the results were not recorded), DBT had the best performance and ultrasound the lowest value (microcalcifications, distortions, asymmetries and some small masses may have remained hidden with this imaging modality). Finally, the pathological size was best correlated with MRI, followed by DBT, US and MG, in descending order. According to these results, the use of DBT and MRI would have best results at assessing tumor size.
Personal information

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References


