MRI in the pre-operative breast cancer staging before and after the introduction of digital breast tomosynthesis (DBT): has anything changed?

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Purpose

Surgical planning and treatment of patients with breast carcinoma relies on adequate assessment of the extent of cancer disease, including the size of the primary tumor and the presence of multiple foci, either within the same quadrant (multifocal), in different quadrants (multicentric) and in both breasts (controlateral).

Identification of multifocal or multicentric disease generally is considered to result in higher rates of local recurrence and, thus, a contraindication to breast conservative surgery. Preoperative identification of these patients is important for their appropriate surgical management.

Breast magnetic resonance imaging (MRI) is increasingly being used for the preoperative evaluation of patients with newly diagnosed breast cancer in selected cases (v. EUSOMA GUIDELINES). In fact MRI appears to depict more malignant lesions than either Mammography (MX) or Ultrasound (US) [1-4].

Recent studies [5-10] reported that Digital Breast Tomosynthesis (DBT) seems to improve the lesions detection vs MX or US. DBT provides a 3D imaging capability that allows more accurate evaluation and identification of lesions by enabling better differentiation between overlapping tissues.

The introduction of DBT in clinical practice, and above all in preoperative staging, raised the question if the increase in detection rate using MRI vs conventional imaging was still applicable using DBT in preoperative staging.

The purpose of this retrospective study is to compare the diagnostic accuracy of MRI and conventional imaging techniques (digital mammography [DM] and ultrasound [US]) combined or not with DBT in pre-operative breast cancer assessment and to determine the effects on surgical treatment.

Methods and Materials

We retrospectively reviewed 132 newly diagnosed breast cancer patients (146 operated breasts), who underwent pre-operative conventional imaging modalities and MRI between January 2009 and June 2011.

The patients were divided into two groups: those who had DBT in addition to DM and US (Group-1:76/132, 88 operated breasts) and those who didn't undergo to DBT (Group-2:56/132, 58 operated breasts).
Any patient had undergone breast surgery before, had neoadjuvant chemotherapy treatment or presented breast implants. Main indications for preoperative breast MRI were dense breasts (BI-RADS 3,4), suspect of multifocal/multicentric/controlateral lesions, lobular cancer, discrepancy in size of >1 cm between MX and US findings, women at high-risk for breast cancer.

The MRI images were acquired with a 1.5 T MRI scanner with a seven channel dedicated breast coil. The dynamic study was performed with a three-dimentional T1-weighted gradient recolled echo (GRE) acquisition in the axial plane, obtained before and for five times after intravenous bolus injection of 0,2 ml/Kg body weight Gd-BOPTA at rate of 2ml/sec, followed by 20ml saline solution flush.

The DBT images were acquired with a Selenia Dimensions (Hologic), that acquired combined 2D and 3D images within the same compression for each projection (CC and MLO). DBT images acquisition was performed with a 15° angle (±7,5°) and 15 low dose expositions were acquired; then, these images were reconstructed with slice separation of 1 mm.

Statistical analyses were performed to compare the diagnostic accuracy of imaging techniques (DM, US, DBT and MRI).

In addition, we evaluated how breast MRI affected surgical management in the two groups, and if so, whether the patient benefited from this change.

**Results**

In Group 1 were included 76 patients (88 operated breasts), with 119 malignant lesions.

Overall sensitivity was 94,1% (112/119) for MRI, 80,6% (96/119) for DM+DBT and 83,1% (99/119) for DM+DBT+US (P<0,05). Sensitivity in localizing multifocal/multicentric breast cancers was 80% (16/20) for MRI, 65% (13/20) for DM+DBT, and 70% (14/20) for DM+DBT+US. No statistically significant difference was found between these three groups (P>0,05). In localizing controlateral lesions, sensitivity was 100% (7/7) for MRI, 57% (4/7) for DM+DBT, and 57%, (4/7) for DM+DBT+US (P<0,05).

Overall specificity was 72,2% (39/54) for MRI, 77,7% (42/54) for DM+DBT, and 83,3% (45/54) for DM+DBT+US (P>0,05).

In Group 2 were included 56 patients( 58 operated breasts), with 95 malignant lesions.
Overall sensitivity was 93.6% (89/95) for MRI, 66.3% (63/95) for DM, and 73.6% (70/95) for DM+US (P<0.05). Sensitivity in localizing multifocal/multicentric breast cancers was 73.3% (11/15) for MRI, 46.7% (7/15) for DM, and 46.7% (7/15) for DM+US. The difference was found statistically significant (P<0.05). Sensitivity in localizing contralateral lesions was 100% (4/4) for MRI, 50% (2/4) for DM, and 50% (2/4) for DM+US (P<0.05).

Overall specificity was 72.7% (24/33) for MRI, 81.8% (27/33) for DM, and 81.8% (27/33) for DM+US (P>0.05).

Comparing the sensitivity of the different imaging modalities in the two groups, a statistically significant difference (P<0.05) was found between the overall sensitivity of DM+DBT in Group 1 (80.6%), and of DM in Group 2 (66.3%), and comparing DM+DBT +US sensitivity (83.1%) in Group 1 and DM+US sensitivity (73.6%) in Group 2. No statistically significant difference was found between the sensitivity of DM+DBT in Group 1 (80.6%) and DM+US (73.6%) in Group 2.

Pre-operative MRI changed surgical treatment in 12/88 (13.6%) in Group 1 with 7/88 (8%) conversion from breast conservative treatment (BCT) into mastectomy and 5/88 (5.6%) additional excisions, and in Group 2 in 12/58 (20.6%) with a conversion from BCT into mastectomy in 10/58 (17.2%) and 2/58 (3.5%) additional excisions. Overall pathologic confirmation of malignancy was respectively 8/12 (66.7%) in Group 1 and 9/12 (75%) in Group 2 in the surgical specimens. The difference between the changes from BCT into mastectomy between the two groups was found statistically significant (P<0.05).

Images for this section:
Fig. 1: 48 year-old woman with dense breast (BIRADS D3) with a palpable lump in the left breast: CC view demonstrated an irregularly shaped opacity in the lower-outer quadrant.
**Fig. 2:** CC view with DBT showed an additional irregularly shaped opacity associated with structural distortion between the lower quadrants of the left breast.

**Fig. 3:** The patient underwent pre-operative MRI: (Axial MIP image): MRI confirmed the presence of the two lesions previously detected, and showed an additional enhancing mass behind the nipple in the left breast. Mastectomy of the left breast was performed: the final histological examination confirmed three foci of invasive ductal carcinoma.
Fig. 4: 40 year-old woman first mammography: CC view showed an irregularly shaped opacity associated with casting microcalcifications in the left breast.
Fig. 5: CC view with DBT demonstrated four areas of structural distortion in the inner quadrants of the left breast.
Fig. 6: MLO view showed an irregularly shaped opacity associated with casting microcalcifications in the left breast.
Fig. 7: MLO view with DBT confirmed four areas of structural distorsion in the inner quadrants of the left breast.

Fig. 8: The patient underwent pre-operative MRI: Axial MIP image demonstrated the presence of multifocal-multicentric enhancing masses in the left breast. Mastectomy of the left breast was performed: the final histological examination confirmed a multifocal-multicentric pathology.
Fig. 9: 49 year-old woman with dense breast (BIRADS D3): MLO view demonstrated a small structural distortion in the upper-outer quadrant of the right breast.
**Fig. 10:** MLO view with DBT confirmed the presence of a small distortion in the upper-outer quadrant of the right breast. The micro-histological examination identified an invasive lobular carcinoma (B5b).

**Fig. 11:** The patient underwent pre-operative MRI (Axial MIP image): MRI showed two enhancing masses in the upper-outer quadrant of the right breast associated with a segmental area of irregular enhancement. A wide excision was performed; the final histopathological examination confirmed two invasive lobular carcinomas associated with in situ component.
Fig. 12: 47 year-old woman with dense breast (BIRADS D3): CC view showed a cluster of microcalcifications with ductal disposition in the right breast, affecting the nipple.
Fig. 13: CC view with DBT showed an irregularly shaped opacity in the upper quadrants of the right breast.
**Fig. 14:** No lesions were found in the left breast at mammography.
Fig. 15: MLO view with DBT demonstrated a spiculated opacity associated with structural distorsion in the upper-outer quadrant of the left breast. The micro-histological examination identified an invasive ductal carcinoma (B5b).

Fig. 16: The patient underwent pre-operative MRI (Axial MIP image): MRI showed an enhancing mass in the left breast, corresponding to the opacity and microcalcifications depicted at mammography, and confirmed the presence of a contralateral mass lesion in the right breast. The patient underwent a bilateral mastectomy: the final histopathological examination confirmed the presence of bilateral pathology.
Fig. 17: 50 year-old woman with dense breast (BIRADS D3): CC view showed two cluster of irregular microcalcifications in the left breast. The microhistological examination identified a ductal invasive cancer (B5b).
Fig. 18: No lesions were found in the right breast at mammography.
**Fig. 19:** CC view with DBT demonstrated an area of structural distortion between the upper quadrants of the right breast. The microhistological examination identified a lobular invasive cancer (B5b).

**Fig. 20:** The patient underwent pre-operative MRI (Axial MIP image): MRI showed an area of globular enhancement in the left breast, corresponding to the cluster of microcalcifications depicted at mammography. In the right breast MRI showed a not-mass lesion with additional foci of enhancement. The patient underwent bilateral mastectomy. The final histopathological examination confirmed the presence of bilateral lesions.
Conclusion

Preoperative breast MRI shows the highest sensitivity in detecting breast cancer and to assess tumor extent. Several studies [1-4] and international consensus reported that breast MRI can change surgical management of patients with operable breast cancer by detecting additional malignant lesions.

DBT is one technology being developed to improve detection and characterization of breast lesions, especially in women with non-fatty breasts. It has been recently proposed for breast cancer staging, because of its higher accuracy in depicting malignant lesions than conventional imaging (DM and US) [5-10].

In our experience preoperative DBT showed a higher sensitivity than MX and US, in particular in detecting multiple lesions. A better identification of these lesions with DBT than conventional imaging decreased the difference of detection rate of MRI and consequentially the rate of conversion from BCT into mastectomy, often due to multifocal/multicentric pathology.

Even though in our series the use of DBT improved sensitivity of DM, more rigorous scientific investigation is underway to establish its potential application for clinical breast imaging. On the other hand, breast MRI still shows the highest sensitivity in detecting and staging breast cancer, and correctly modified surgical treatment in 10,5%(8/76) of patients.

The cost-effectiveness of breast MRI and its overall effect on patient survival has to be compared to DBT in further studies.

References


**Personal Information**