

Diagnostic yield of Digital Breast Tomosynthesis (DBT) vs Digital Mammography (DM) in assessing breast cancer: a study on surgical specimens

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Purpose

Background

- State-of-the-art mammography, including digital mammography (DM), is of pivotal importance to achieve early diagnosis of breast cancer, and the only imaging tool proved to reduce mortality [1]. However, the overlap of fibroglandular tissue in dense breasts may affect sensitivity and specificity of DM by masking or mimicking a cancer [2].
- Digital Breast Tomosynthesis (DBT) is a novel imaging tool aimed to overcome tissue overlap, since it is based on a moving x-ray source and a digital detector used to obtain a three-dimensional (3D) volume of thin section data. Images are then reconstructed with proper algorithms to obtain a set of thin image sections parallel to the breast platform [3].
- DBT is still under investigation. This technique is expected to help radiologists in improving: (i) lesions detectability; (ii) the characterization of masses and architectural distortions (especially in dense breasts); (iii) the definition of lesions in terms of dimensions and margins [2-3].

Purpose

The aim of our study was to compare DBT and DM in terms of: (i) diagnostic yield (DY) for cancer (primary endpoint); (ii) the agreement in assessing lesion size (secondary endpoint).

Methods and Materials

Patients

- Over a 1-month period, we prospectively obtained 22 consecutive surgical specimens (13 whole-breasts and 9 quadrants) from 22 patients (age range 41-82 years, mean 62.0 years). Patients were referred to surgery for biopsy-proven cancers in 21 cases and for one axillary nodal metastasis in 1 case with a CUP (Cancer of Unknown Primary) syndrome.
- Pathologic examination of the specimen was used as the standard of reference.

Imaging protocol

- We sequentially performed DM and DBT by using the same digital system (Giotto TOMO, IMS, Bologna, Italy), which implements: (i) a W-target x-ray source, combined with Rh-filter or Ag-filter depending on breast thickness; (ii) an a-Se digital detector (ANRAD LMAM), with a sensitive area

of 24x30 cm² and a squared pixel pitch of 0.085 mm. Surgical specimens were positioned in the system according to criteria showed in Fig. 1 on page 4 .

- We performed DM by acquiring one reference "cranio-caudal" projection followed by one orthogonal projection obtained by rotating the specimen of 90° (Fig. 1 on page 4).
- The DM position corresponding to the largest thickness of the specimen was used to performed one single DBT view. For DBT, the movable x-ray source spanned an overall angular range of ±20°, acquiring 13 projections at the requested position.

Exposure parameters were 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.

Image reconstruction was based on an iterative method that used Total Variation (TV) regularisation, and by default reconstructed voxel size of 0.085 mm×0.085 mm×1.0 mm.

Image analysis

- Images were reviewed in consensus on a dedicated workstation (Raffaello, IMS, Bologna, Italy) by two radiologists with more than 10 years of experience in breast imaging. Both readers were blinded to lesions dimension and pre- and post-surgical histopatological results. DM and DBT images of same patients were presented in independent reading sessions separated by a 4 week interval in order to avoid recall bias. In each reading session, DM and DBT cases were showed randomly.
- For each specimen, readers were asked to record - both on DM or DBT images - the number of lesions they detected, together with the lesion type according to the following categories [4]: mass, microcalcifications cluster, and mixed lesions (in the case of a combination of the two former types). Readers measured the diameter of each lesion by using the electronic calliper. Measurements were performed on the DM projection or DTB slice showing the largest lesion diameter.
- Additionally, readers were asked to express, on a subjective basis: (i) the detectability of lesions, defined as lesions visibility against the background of fibro-glandular tissue (detectability score); (ii) the visibility of lesions margins (margins score) . Detectability was expressed with a 1-5 score as follows: 1=very low; 2=low; 3=mild; 4=good; 5=very good. For the purpose of analysis, readers assessed the background density of each specimen by using the Breast Imaging reporting and Data System (BIRADS) criteria [4]. Margins visibility was expressed as a dichotomic value as follows: 1 when #50% of lesion margins were visible and 0 when <50% of margins were visible.
- Finally, readers expressed the subjective impression of DM or DBT image quality by using the above 1-5 score (image quality score).

Data Analysis

- Analysis was performed on a per-lesion basis.
- First, we estimated the diagnostic yield (DY) of DM and DBT as the ratio between the number of correctly detected lesions over the total number of lesions found at histopathological examination.
- Second, we estimated the agreement between DBT and DM in measuring lesions size by using the Bland-Altman analysis. The intraclass correlation coefficient (ICC) was calculated accordingly.
- Third, we compared the detectability and image quality scores of the two techniques by using the Wilcoxon signed-rank test, and estimated the agreement in attributing the margins score with the Cohen's k statistic. K was interpreted as follows: 0.0-0.20 = poor; 0.21-0.40 = fair; 0.41-0.60 = moderate; 0.61-0.80 = good; 0.81-1.0 = very good.
- Statistical significance was assumed for an alfa value less than 0.5. Binomial exact 95% C.I. were calculated for proportions.

Images for this section:

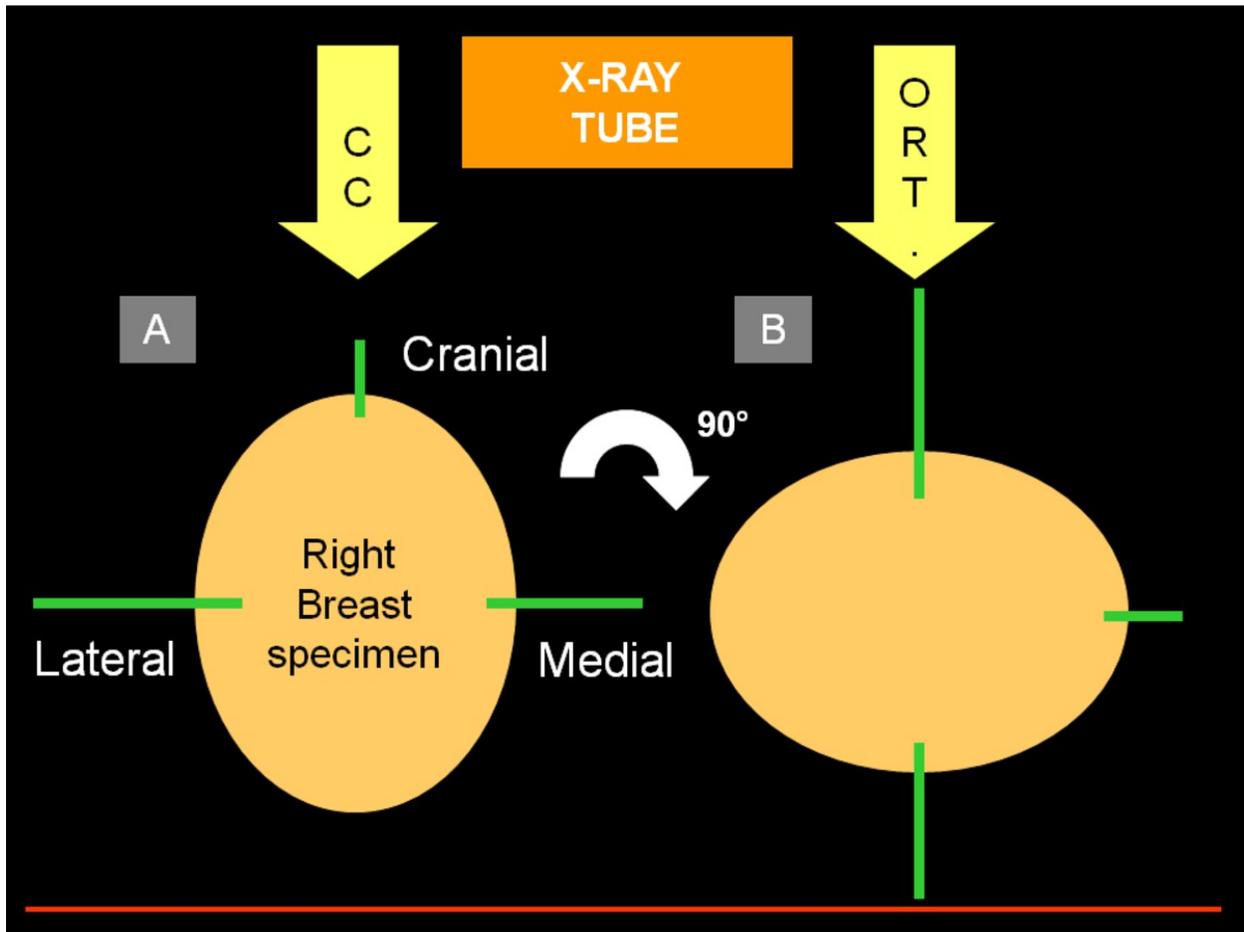


Fig. 1: The surgical specimen was positioned on the sistem plate (red line) by using three surgical wires of different lenght as reference (A). A DM "cranio-caudal" reference projection was obtained accordingly. The second DM orthogonal projection was obtained after rotating the specimen of 90° (clockwise direction for specimens from the right breast and counter-clockwise direction for specimens from the left breast) (B). A single DBT view was obtained in A or B position corresponding to largest specimen thickness. Ort. = orthogonal projection.

Results

Final diagnosis

- A total of twenty-seven lesions on 21 specimens were confirmed at pathologic examination. Four specimens showed 2 lesions each, whereas 1 specimen showed 3 lesions. The remaining specimen from the patient with CUP syndrome was excluded from analysis, since it showed no lesions at pathological examination.
- An overview of lesions types and appearance on DM and/or DBT is shown in [Table 1](#) on page 7.

Diagnostic yield and agreement in measuring lesions size

- DBT detected 27/27 lesions, corresponding to a DY of 100% (95% C.I. 87.2-100), whereas DM detected 24/27 lesions, corresponding to a DY of 88.8% (95% C.I. 70.8-97.6). Lesions missed by DM were: 3 IDC with intraductal component appearing as a mass ([Fig. 2](#) on page 8), a mixed lesion and a cluster of microcalcifications ([Fig. 3](#) on page 9).
- Largest lesions diameters as measured by DBT or DM on 24/27 lesions visible with both techniques are reported in [Table 2](#) on page 10. According to the Bland and Altman analysis, average difference between DBT and DM measurements was 0.4 mm, with 95% limits of agreement of -4.9 to +5.8 mm (). ICC was 0.92. Lesions missed by DM ranged 3-9 mm in diameter.

Comparison of subjective scores

- No significant difference ($p>0.5$) was found in detectability and image quality scores attributed by readers to DBT and DM ([Table 3](#) on page 12) ([Fig. 5](#) on page 13 - [Fig. 6](#) on page 14). Specimen density was assessed as follows: 8 cases BI-RADS 1-2 and 14 cases BI-RADS 3-4. Lesions missed by DM occurred in specimens with a BI-RADS density of 2 in one case (ICD with i.s. component appearing as a mass showed in [Fig. 2](#) on page 8) and 3-4 in two cases (remaining lesions cited above, including that showed in [Fig. 3](#) on page 9).
- There was no agreement ($k=0.043$) in the margins visibility score as attributed by using DBT and DM (24/27 comparable lesions). This because readers detected more than 50% of lesions margins in 23/24 lesions (95,8%; 95% C.I. 78.8-99.9) with DBT and in 8/24 patients only with DM (33.4%; 95% C.I. 15.6-55.3) ([Fig. 7](#) on page 15). Of note, the margins score for DM cases was assumed to be the highest one of two projections.

Images for this section:

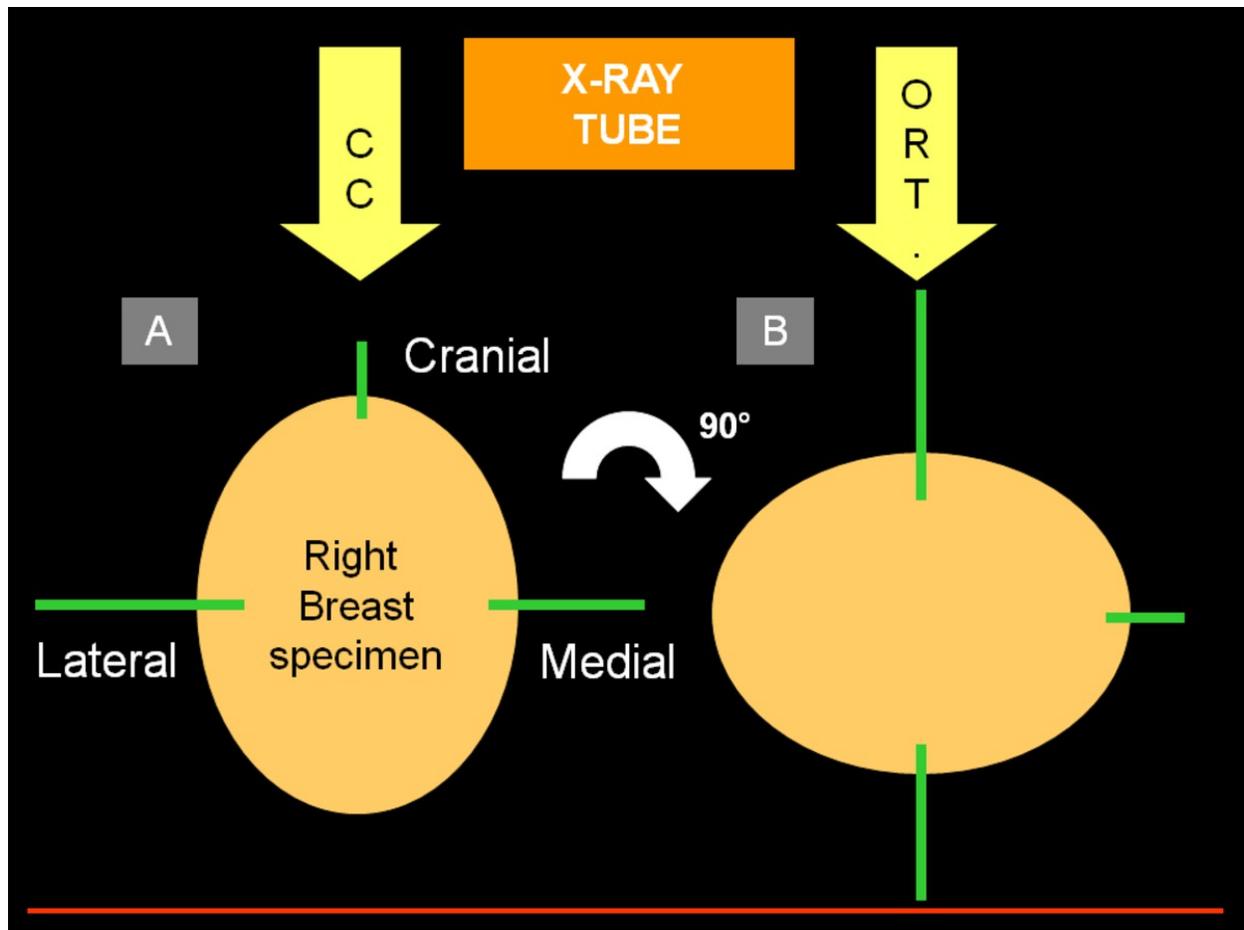


Fig. 1: The surgical specimen was positioned on the sistem plate (red line) by using three surgical wires of different lenght as reference (A). A DM "cranio-caudal" reference projection was obtained accordingly. The second DM orthogonal projection was obtained after rotating the specimen of 90° (clockwise direction for specimens from the right breast and counter-clockwise direction for specimens from the left breast) (B). A single DBT view was obtained in A or B position corresponding to largest specimen thickness. Ort. = orthogonal projection.

Final diagnosis	Number of specimens	Number of lesions			Total
		Mass	Microcalcifications	Mixed	
IDC	6	10	-	-	10*
IDC + i.s. component	7	5	1	2	8**
Papillary carcinoma	1	1	-	-	1
DCIS	4	-	-	4	4
ILC	3	4	-	-	4***
Total	21	20	1	6	27

Table 1: Distribution of breast lesions on 21 surgical specimens according to the appearance on DM and/or DBT. * 1/10 specimen containing 3 lesions and 2/10 specimens containing 2 lesions each. **1/8 specimen containing 2 lesions. ***1/4 specimen containing 2 lesions.

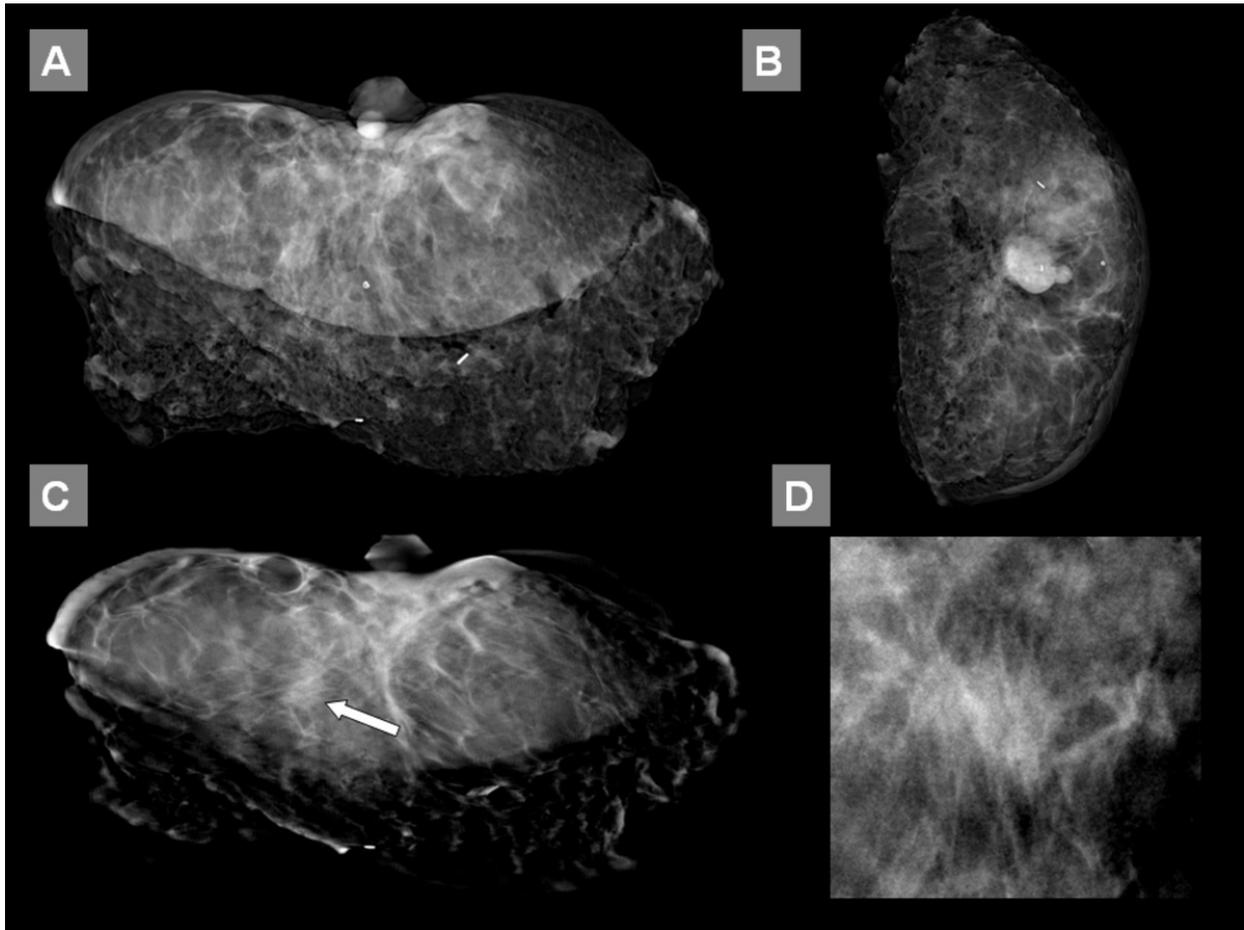


Fig. 2: 82 years-old patient operated for an IDC with i.s. component of the right breast (confirmed at histopathological examination of the specimen). Specimen density was assessed as 2 according to BI-RADS criteria. Readers missed the lesion both on DM cranio-caudal (A) and orthogonal (B) projections. However, the lesion was correctly detected as a mass in the 1-mm DBT thin slice (arrow in C). Lesion is magnified in D.

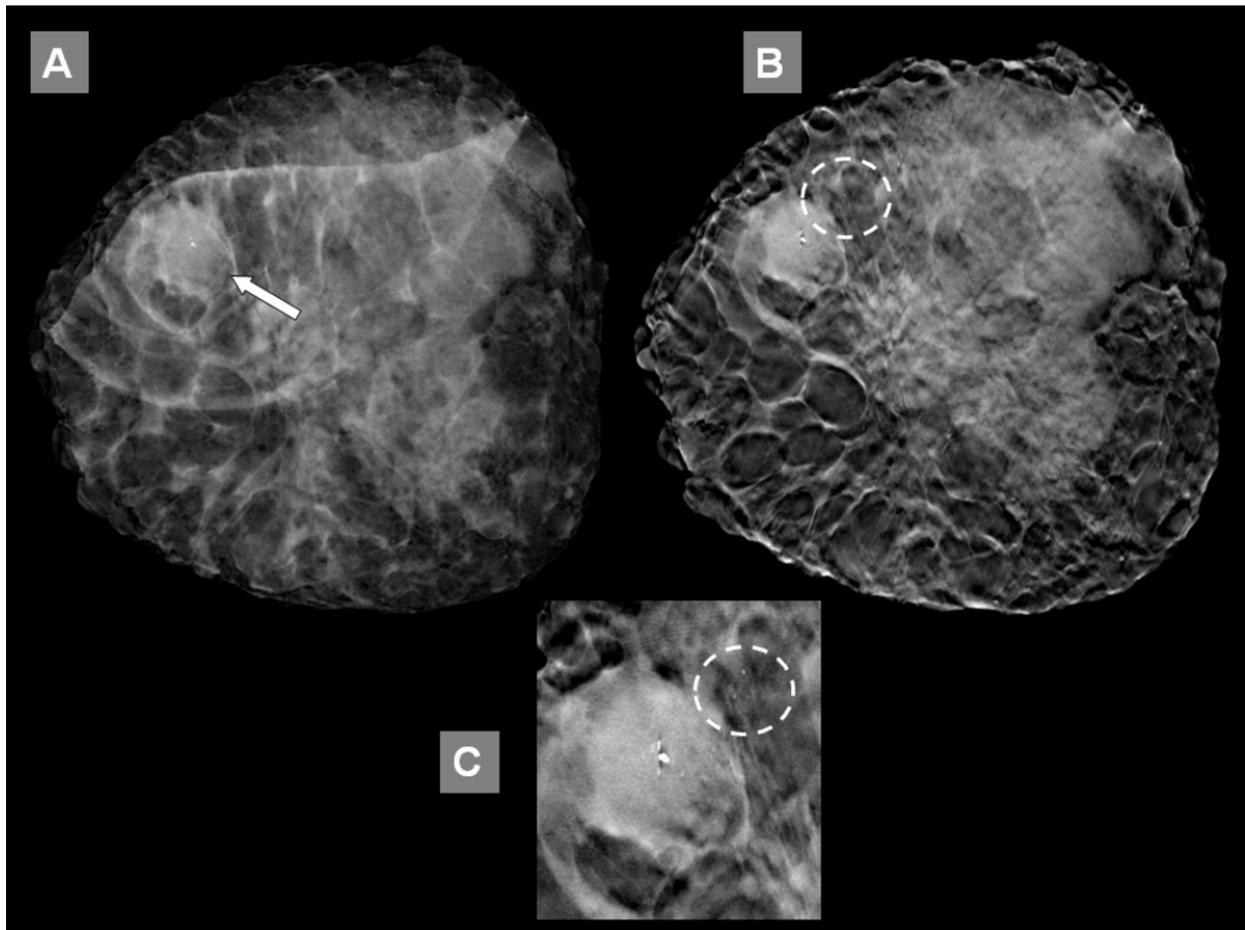


Fig. 3: 40 years-old patient who underwent left skin-sparing mastectomy because of two IDC with i.s. component as confirmed by histopathological examination of the specimen. BI-RADS density of the specimen was assessed as 3. By using DM (A), readers were able to detect the largest mixed lesion only (arrow). DBT led to correctly detect one additional lesion appearing as a 3 mm large cluster of microcalcifications (circle in B). The region containing the lesions is magnified in C.

Lesion largest diameter	Mean	SD	Range
DM (mm)	14.2	8.1	3.0-33.0
DBT (mm)	14.6	8.9	3.0-38.0

Table 2: Lesions size as assessed by DM and DBT.

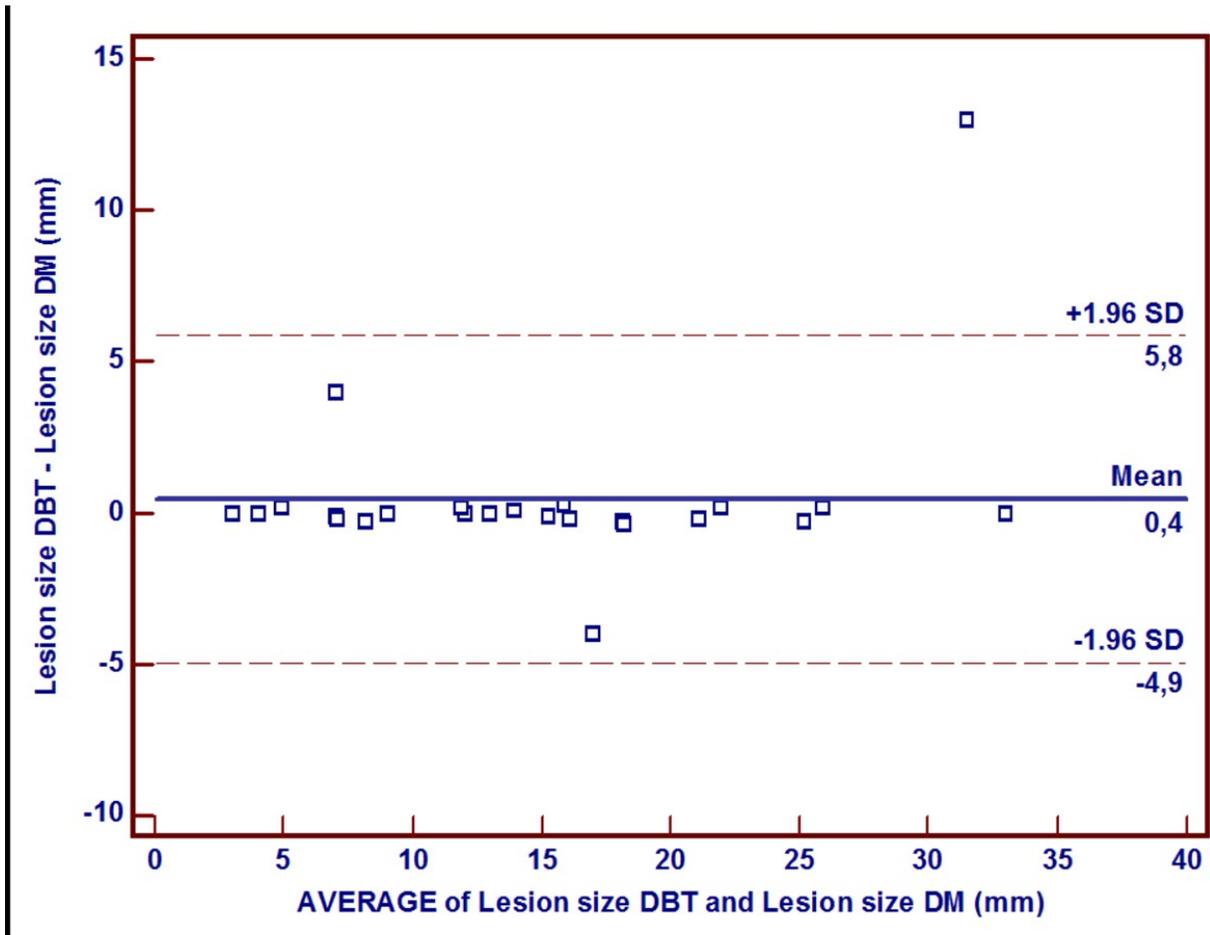


Fig. 4: Results of Bland and Altman analysis for DBT and DM agreement in terms of lesions size measurement.

	DBT	DM	p
Detectability score	4.81±0.60	4.52±1.03	N.S.
Image quality score	4.90±0.30	4.84±0.35	N.S.

Table 3: Average subjective scores attributed by readers to lesions detectability and image quality for both imaging techniques. N.S. = not significant.

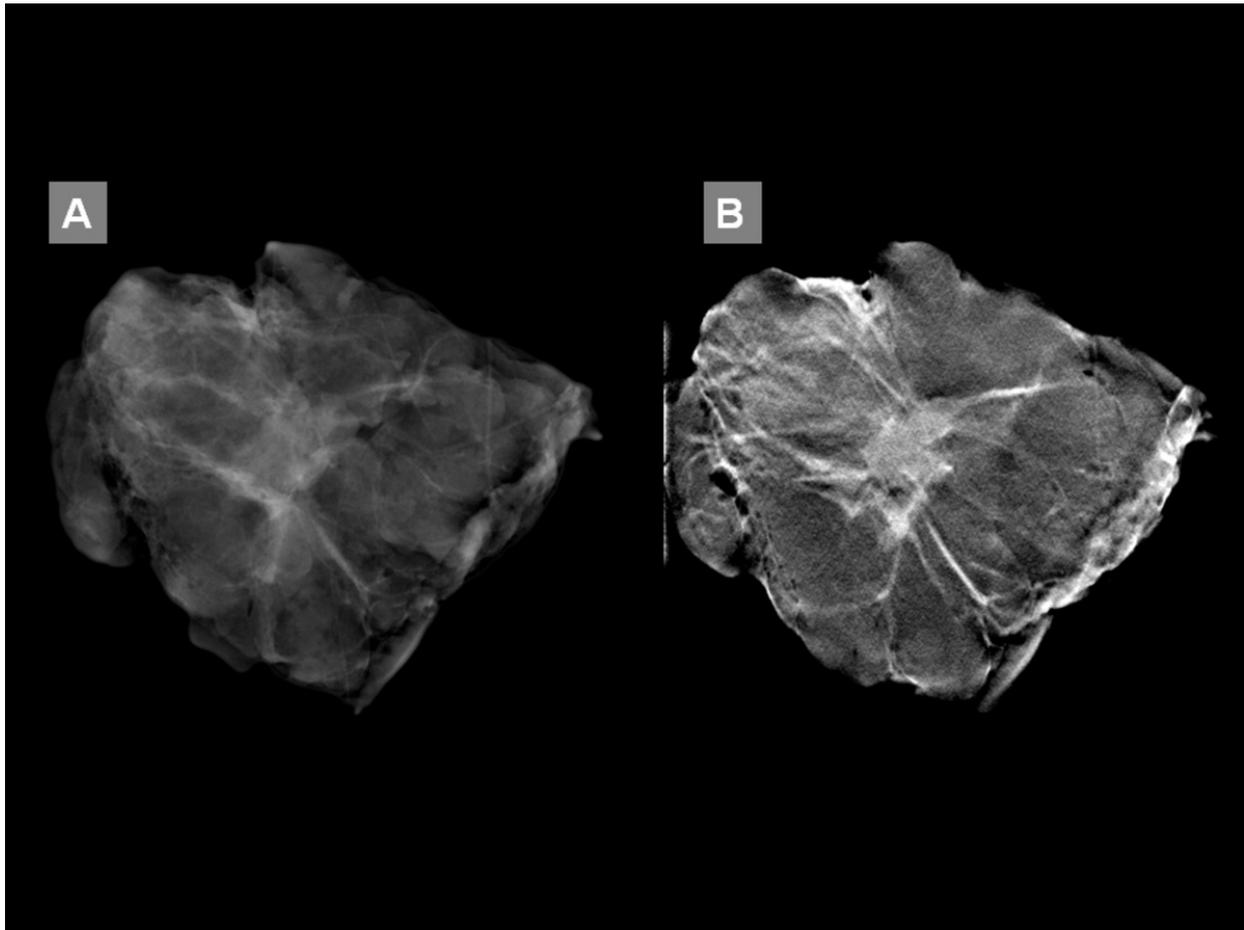


Fig. 5: 55 years-old patient who underwent surgery for IDC. Readers attributed the same detectability score value of 4 to the lesion identified both on DM (A) and DBT 1-mm thin slice (B). BI-RADS of the specimen was assessed as 1.

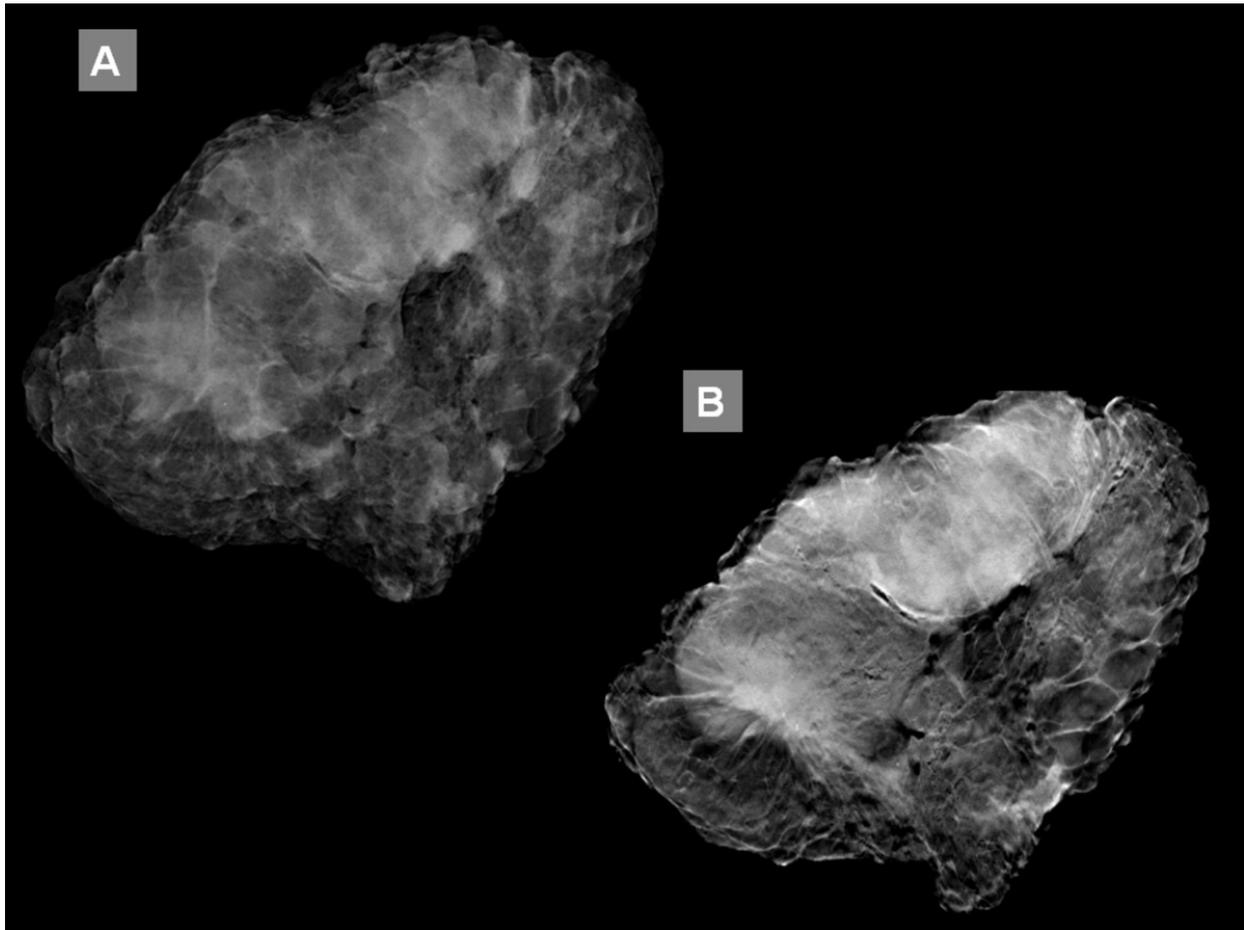


Fig. 6: 44 years-old patient operated for IDC with i.s. component. DM (A) and DBT (B) had the same image quality score of 5.

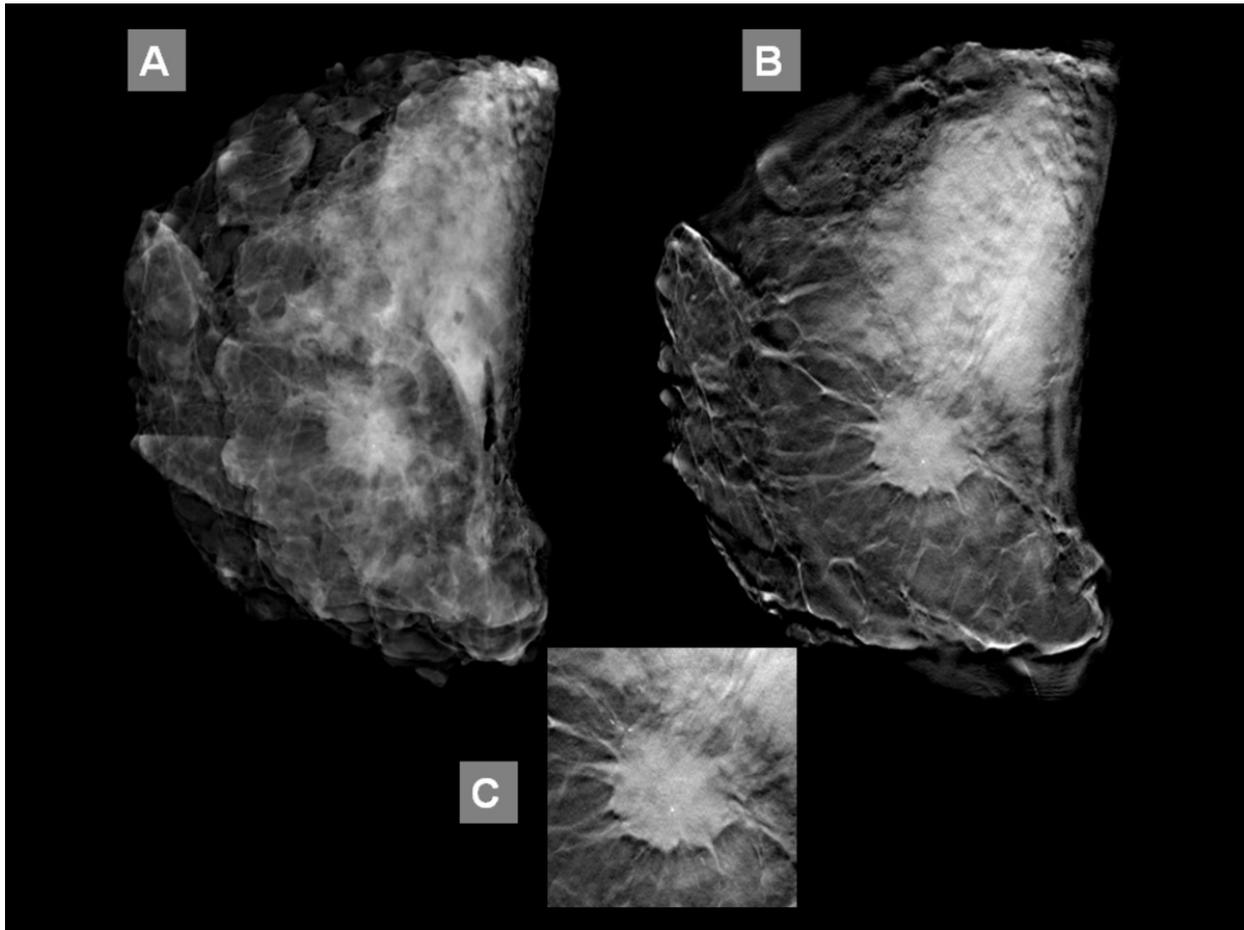


Fig. 7: 56 years-old patient who underwent surgery for IDC with i.s. component. DM crano-caudal projection only is shown (A). As evident by the comparison with DBT image (B), lesions margins are better identified all around the lesion contour with the 3D technique. Lesion is magnified in C.

Conclusion

Limitations

- Main study limitation is the small sample size. However, the collection of new cases is a work-in-progress in our Institution. Additional results seem to confirm the trend we showed in this poster.

Conclusions

- Regardless of lesion type (mass and/or microcalcifications), DBT showed higher DY than DM by retrieving small lesions, prevalently in dense specimens. This is in accordance with previous results showing that DBT increases the sensitivity for cancer by reducing breast tissues overlapping [5-6].
- DBT showed a reasonable agreement with DM in assessing lesions size (measurements not exceeding 6 mm). DBT and DM were equivalent also in terms of lesions visibility and image quality, suggesting that DBT has the potential to replace DM in the evaluation of surgical specimens. This is in accordance with the better margins definition we observed by using DBT. Further studies are required to assess whether this assumption is valid for the clinical scenario.

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Personal Information

Thank you for the interest in this poster.

For any questions, do not hesitate to contact me.

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