Image quality in synthetic mammograms obtained from 15° and 40° digital breast tomosynthesis: a preliminary comparative phantom study.

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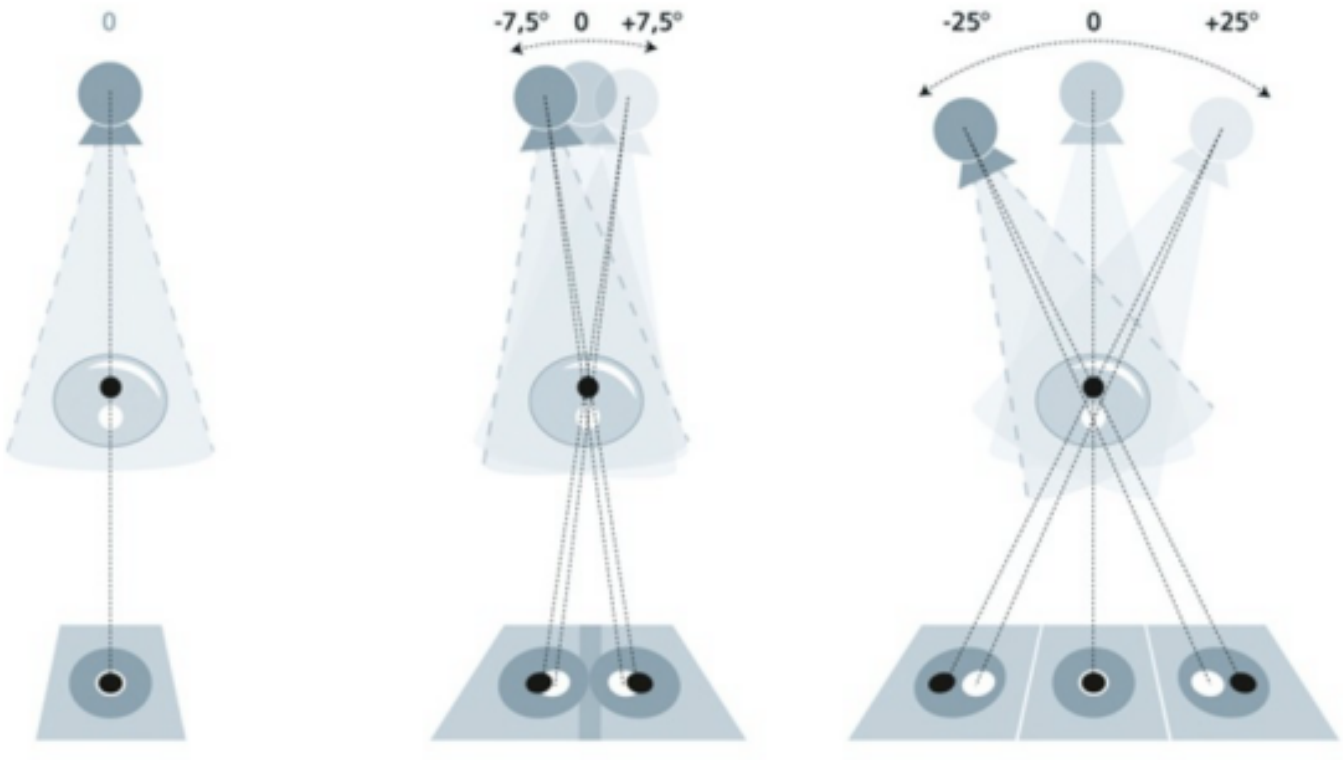
The introduction of the DBT

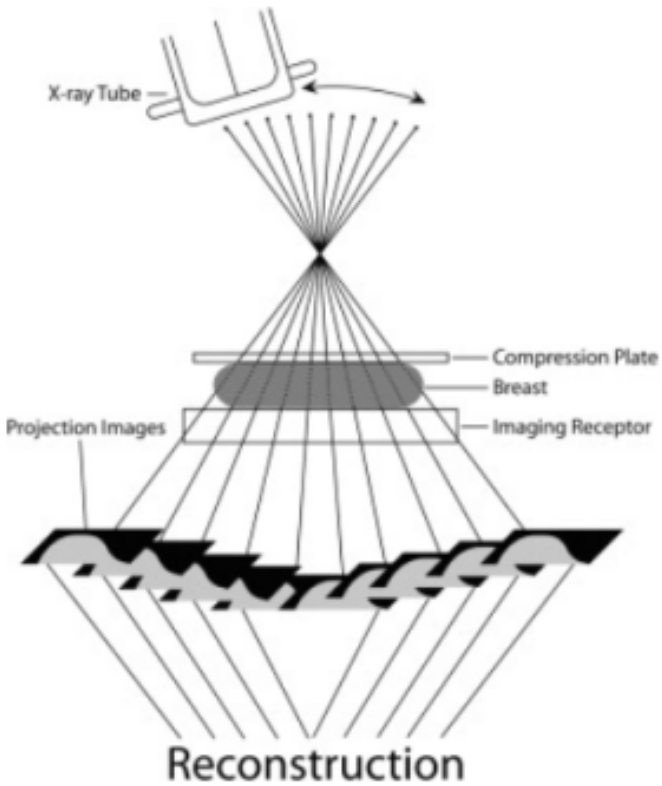
Digital Mammography (DM) vs Digital Breast Tomosynthesis (DBT)

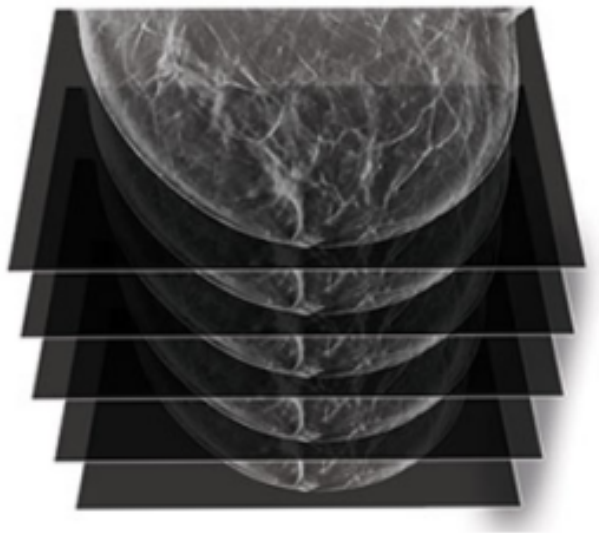


DBT reduces the limitation of DM caused by the overlapping of breast tissues.

DBT

- DBT is a pseudo-three dimensional (3D) technique that allows to obtain a set of breast image planes by acquiring a limited number of breast projections from a narrow angular range.
- A set of fixed-thickness "slices" is reconstructed through filtered back-projection or iterative recostruction algorithm.





Narrow-angle DBT vs Wide-angle DBT

Narrow-angle DBT $\longmapsto$ Better identification of microcalcifications.

Wide-angle DBT $\longmapsto$ Better spatial resolution in depth.
$\hookrightarrow$Better identification of breast lesions.

Since wide-angle DBT is characterized by a better spatial resolution in depth but also by worse performance in detecting microcalcifications with respect to narrow-angle DBT, SM images could play an important role as a support for DBT examinations.

The aim of this phantom study was to perform an image quality comparison between synthesized mammograms reconstructed from digital breast tomosynthesis acquisitions with 15° (SM_{15}) and 40° (SM_{40}) x-ray tube angular range in a commercial system.

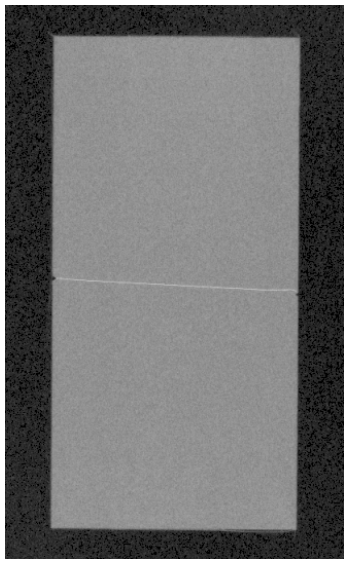
Mammographic machine

Amulet Innovality
(Fujifilm Medical System)

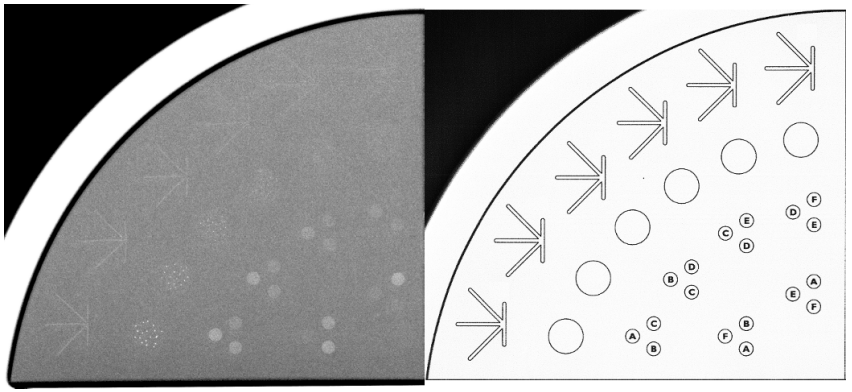
The Amulet Innovality model allows the selection of two different DBT acquisition modes:

- the standard (ST) mode, which uses a narrow angular range of projections (15°);
- the high resolution (HR) mode, which uses a wide angular range of projections (40°).

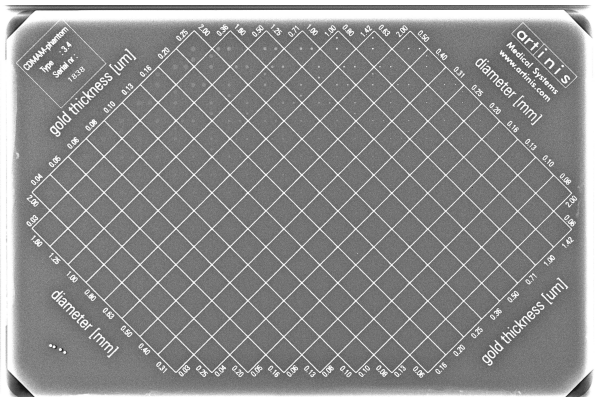
Phantoms



Home-made phantom



TORMAM phantom



CDMAM phantom

Image analysis

The image quality comparison was conducted by evaluating spatial resolution, noise and contrast properties of the SM images, through the calculation of the:

- Modulation Transfer Function (MTF),
- image contrast,
- Signal-to-Noise Ratio (SNR),
- Contrast-Detail (CD) curves.

- The home-made phantom was specifically assembled to assess the spatial resolution properties of the images;

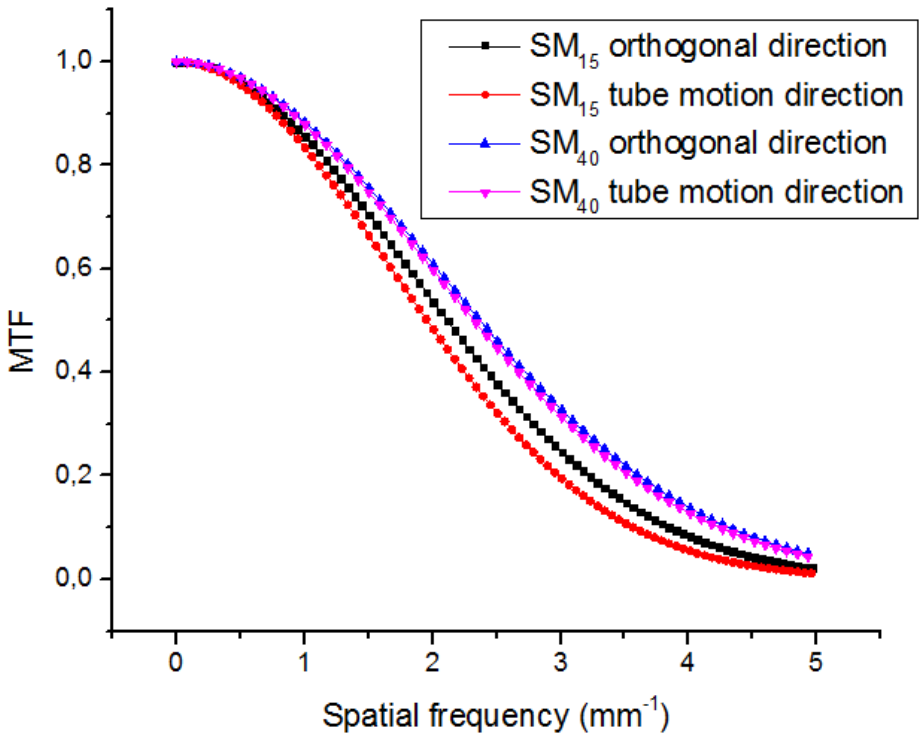
- A 4 cm thick PMMA phantom was employed to investigate the noise properties of the images;

- The TORMAM phantom was used to evaluate the contrast properties of the images;

- The CDMAM phantom was employed to conduct a contrast-detail analysis.

MTF and image contrast

MTF

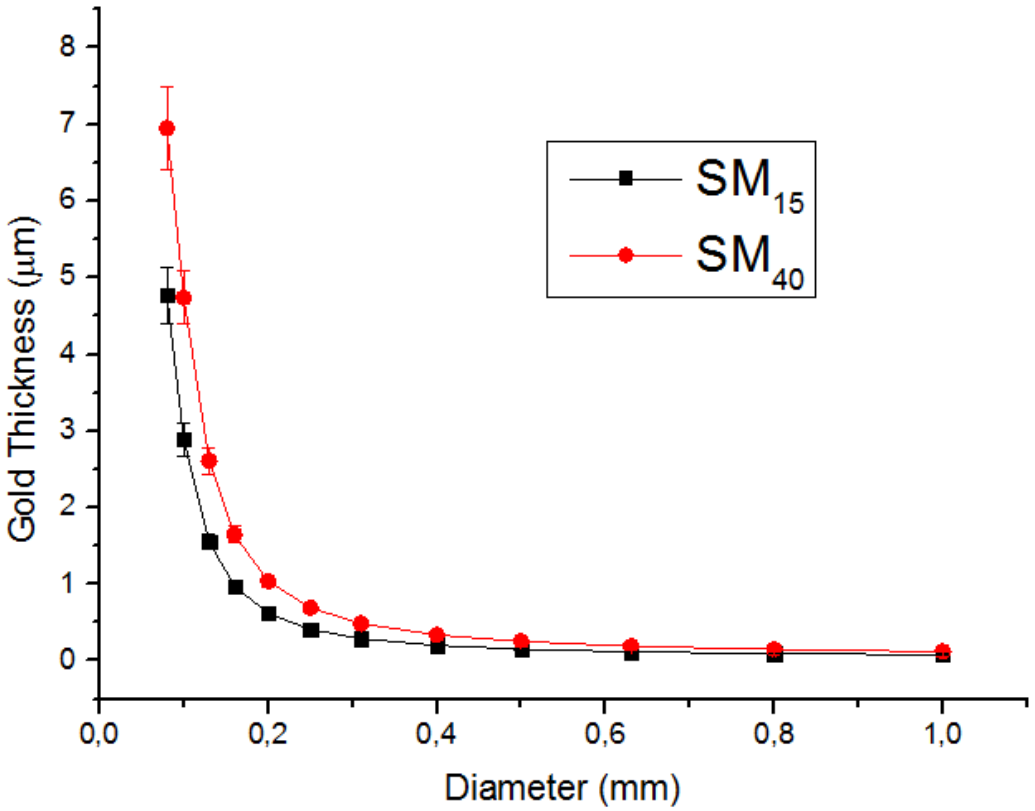


Contrast values - TORMAM

Insert group	Insert type	Contrast SM_{15}	Contrast SM_{40}
1	B	0.36 ± 0.06	0.34 ± 0.04
	A	0.34 ± 0.04	0.37 ± 0.01
	C	0.11 ± 0.02	0.13 ± 0.02
2	C	0.16 ± 0.04	0.17 ± 0.04
	B	0.29 ± 0.03	0.30 ± 0.05
	D	0.13 ± 0.02	0.09 ± 0.08
3	D	0.10 ± 0.02	0.05 ± 0.02
	C	0.13 ± 0.02	0.17 ± 0.03
	E	0.09 ± 0.01	Not visible
4	E	0.23 ± 0.02	Not visible
	D	0.13 ± 0.03	0.20 ± 0.03
	F	Not visible	Not visible
5	A	0.51 ± 0.04	0.51 ± 0.05
	F	Not visible	Not visible
	B	0.32 ± 0.02	0.36 ± 0.01
6	F	Not visible	Not visible
	E	0.07 ± 0.02	Not visible
	A	0.46 ± 0.01	0.43 ± 0.04

CD curves and SNR values

Contrast-Detail (CD) analysis



Signal-to-Noise Ratio (SNR)

SM_{15}	SM_{40}
38.6 ± 6.1	20.2 ± 2.8

Conclusions

— The aim of this phantom study was to present an image quality comparison between SM images obtained from DBT acquisitions with 15° and 40° x-ray tube angular range.

— The image quality comparison was conducted by evaluating spatial resolution, noise and contrast properties of the images through the calculation of the MTF, contrast level, SNR and CD curves

— Our results showed that SM_{40} images expressed higher MTF than SM_{15}, but similar contrast values and lower SNR levels. Additionally, lower CD performances were found for SM_{40} with respect to SM_{15}.

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