Digital Breast Tomosynthesis: Mean Glandular Dose estimation using Monte Carlo code

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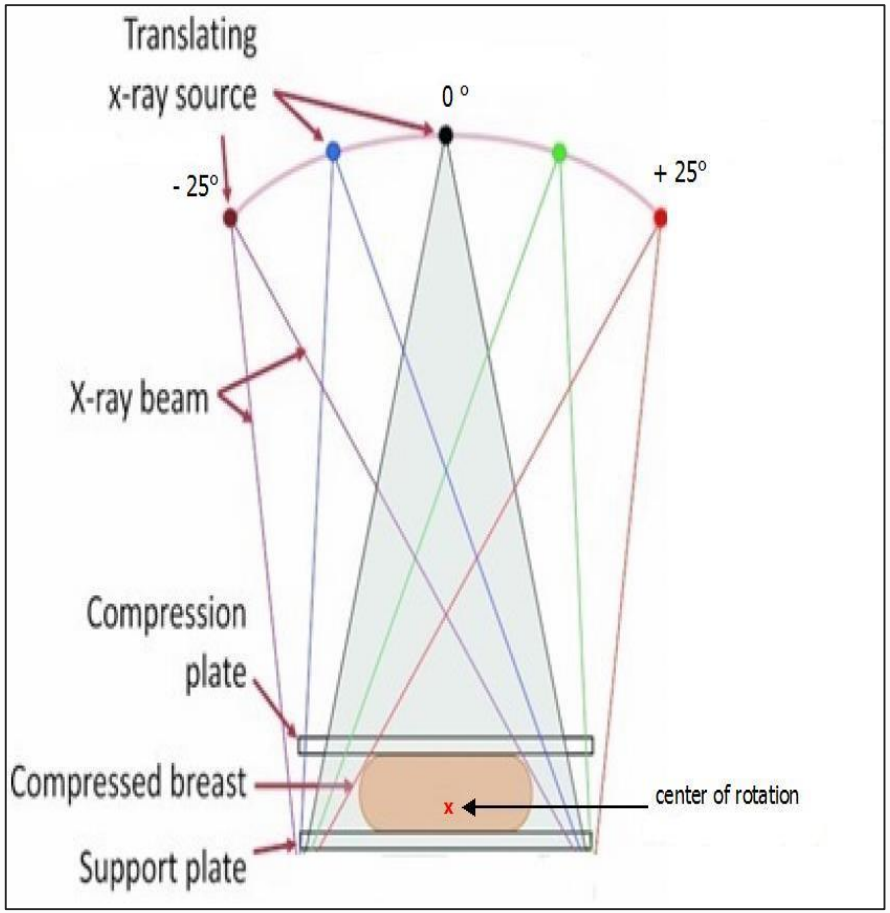
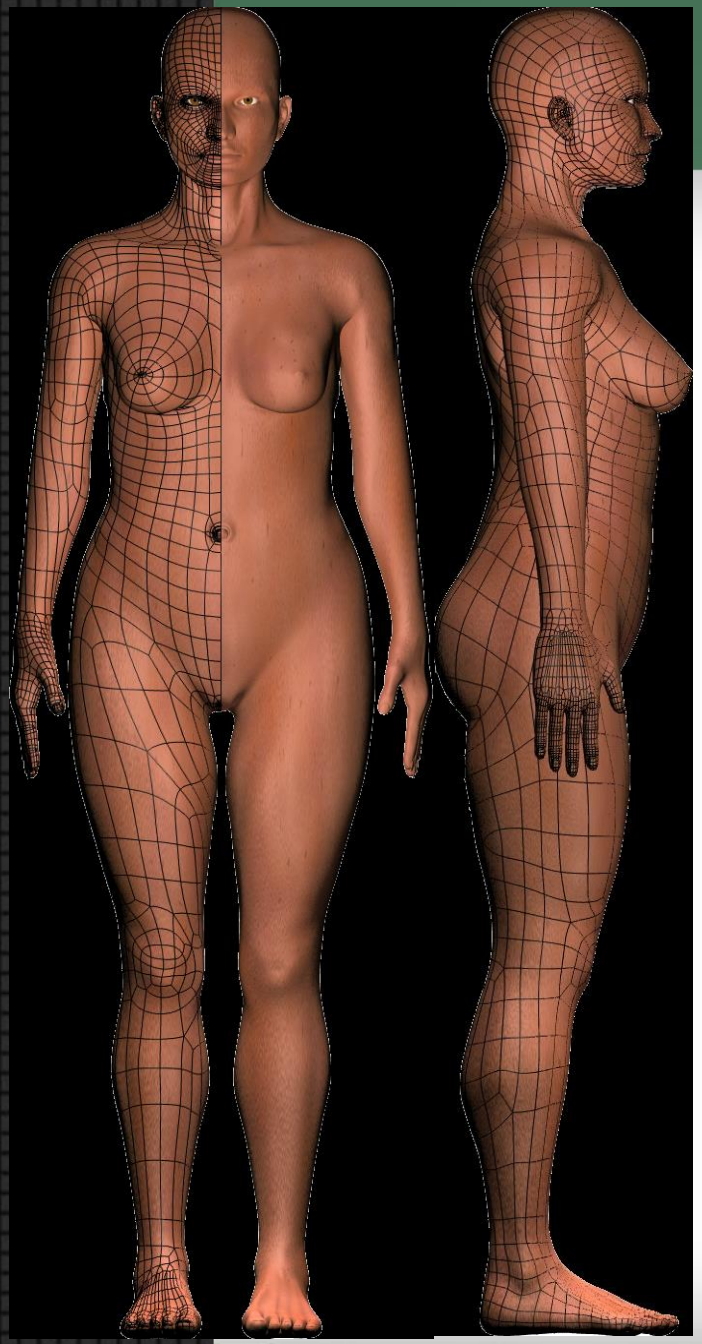
Introduction



3D breast imaging using the technique of digital tomosynthesis may have the ability to improve the visualization of tissues which would be superimposed on a conventional mammogram. Early results with Digital Breast Tomosynthesis (DBT) are promising. When it is performing a DBT acquisition, the system acquires 25 projections over a 50° angular range (from -25° to +25°).

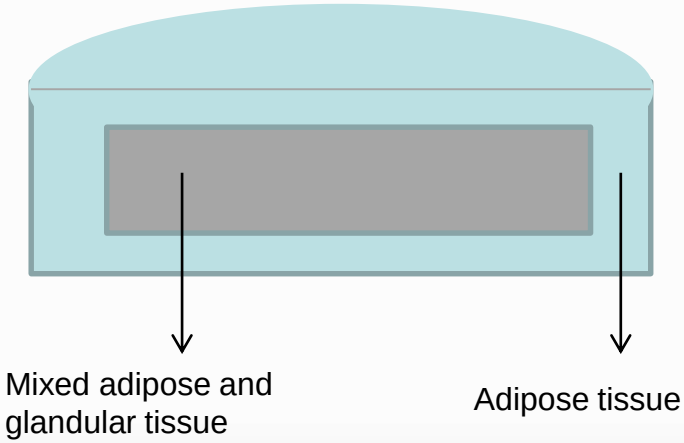
Purpose



Voxel Phantom

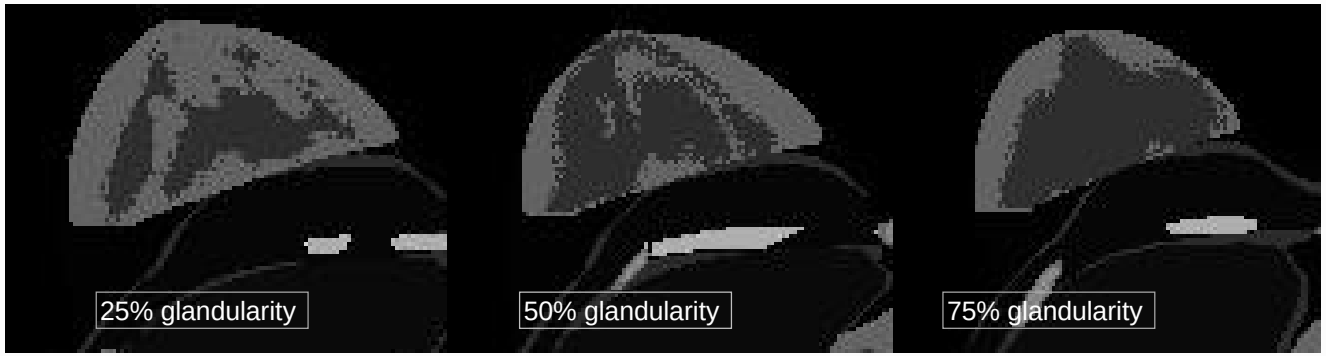
To study the dosimetric properties of a combined DBT/DM system (MAMMOMAT Inspiration Siemens®) for a W/Rh anode/filter combination and to estimate the mean glandular dose (MGD) of the breast during DBT examination, using Monte Carlo code and voxel phantom in standing posture.

Simple geometrical model of the breast used previously for calculation of the MGD.



Materials and Methods

EGSnrc Monte Carlo code was used to simulate the interaction of photons with matter included a female voxel phantom (breast thickness of 2 to 8 cm and 1% to 100% glandular fraction). For each imaging condition were computed the glandular dose for the zero degree projection angle and the glandular dose for total scan rage of continuous X-ray tube motion. The calculations were made for the x-ray spectra from a W target (tube voltage range 26-34 kV) filtered by Rh. Air kerma measurements were performed with ionization chamber at the central ray of the zero-angle projection.



Horizontal slices through 5 cm breasts voxel phantoms with 25%, 50%, 75% glandularity.

Results

Monte Carlo Results for Mean Glandular Dose (mGy/mGy)

Breast Thickness (cm)	1% Glandular Fraction	25% Glandular Fraction	50% Glandular Fraction	75% Glandular Fraction	100% Glandular Fraction
2	1.472	1.385	1.273	1.183	1.215
4	0.883	0.864	0.765	0.707	0.708
5	0.499	0.492	0.439	0,406	0,414
6	0,303	0.363	0.349	0.341	0.349
8	0.169	0.191	0.213	0.243	0.259

Calculated Results for Mean Glandular Dose (mGy)

Breast Thickness (cm)	1% Glandular Fraction	25% Glandular Fraction	50% Glandular Fraction	75% Glandular Fraction	100% Glandular Fraction
2	0.673	0.632	0.581	0.540	0.555
4	0.995	0.974	0.861	0.796	0.798
5	0.833	0.822	1.469	1.359	1.385
6	1.188	1.342	1.495	1.707	1.820
8	1.168	1.399	2.161	2.109	2.162

Conclusion

- For an average breast (5 cm thick with 50% of glandular tissue) the MGD was 1.469 mGy, below the achievable value (2 mGy) defined by the European Protocol.

- The voxel phantom is a powerful tool for the study of breast dosimetry.

- When there is some knowledge of the distribution of glandular tissue within the breast, the results of this study can be used to provide an estimated mean glandular dose for individual cases.