Estimation of the average patient doses in digital mammography using test objects

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Purpose

Compare Mean Glandular Dose (MGD) from exposure settings on patients to results of test objects in different configurations

Materials and Methods

- 18 DR systems of different make and model. All systems passed the acceptance test following the EUREF [1, 2]
- Patient dose study:
  - Automated collection of relevant DICOM tags for dose calculation of at least 125 views/per system (CC and MLO) and automated dose analysis
  - MGD calculation according to Dance et al [3]
  - The “running average” of the individual dose values was calculated as a function of thicknesses: each point in the curve represents the average dose from thicknesses 5mm smaller to 5mm bigger. Curve fit through the data for each system

1 European guidelines for quality assurance in breast cancer screening and diagnosis
2 Supplement to the European Guidelines
3 Dance et al. Phys. Med. Biol. 45, 3225-3240 (2000)

Materials and Methods

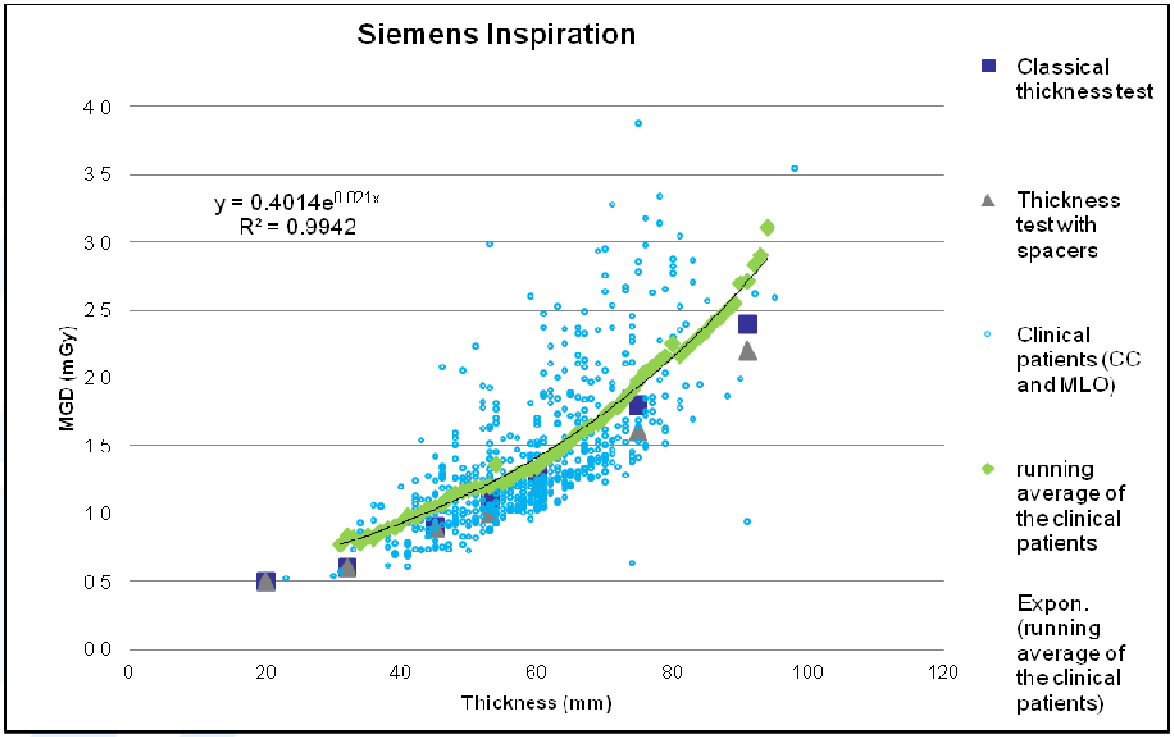
- Physics' estimation of dose in 2 different ways:
  1. with PMMA plates[1]
     ⟹ Classical thickness test
  2. with PMMA plates and using spacers to make the compressed thickness the same as the corresponding breast [2]
     ⟹ Thickness test with spacers

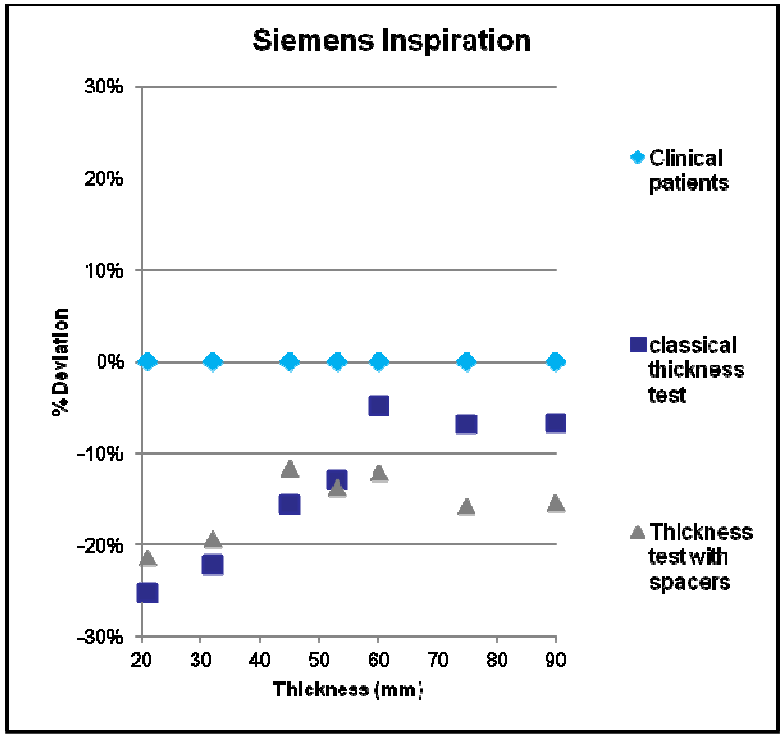
- Correlation of patient dose and this physics' estimation
  - Percentage deviation between patient dose running average and physics' estimation of corresponding thickness

1 European guidelines for quality assurance in breast cancer screening and diagnosis
2 Supplement to the European Guidelines

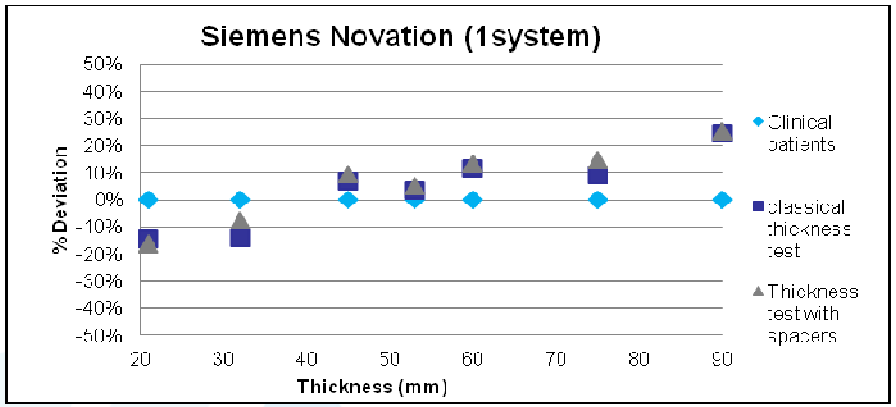
Results

- Patient data and correlation with physics' estimation
  - Example for Siemens Inspiration

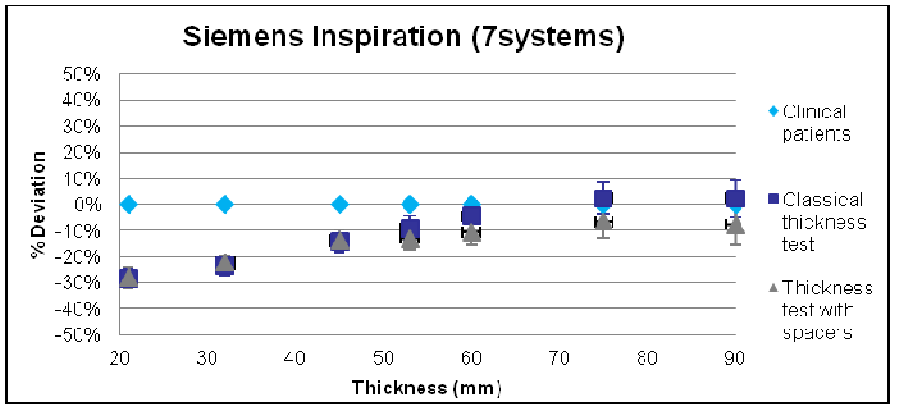




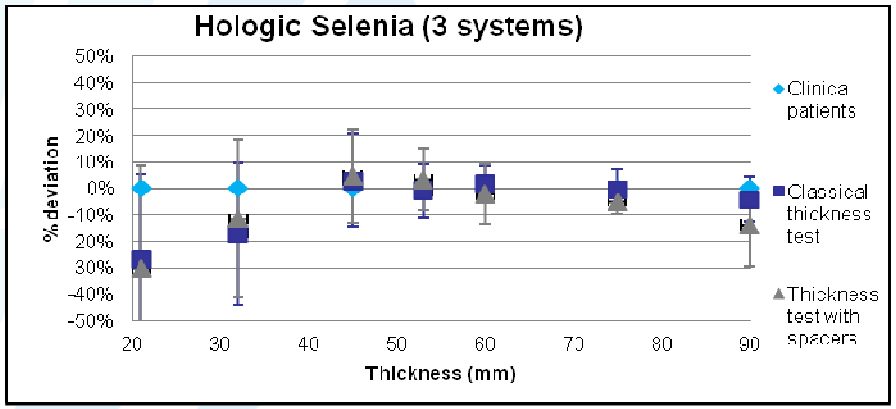
Results



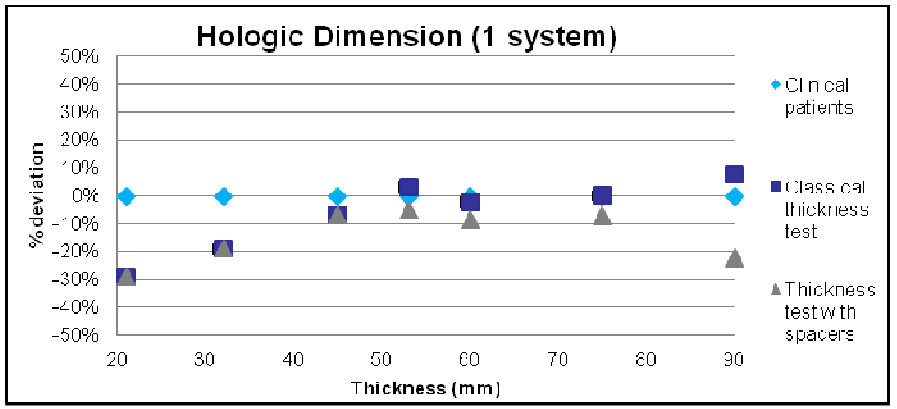
Number of vieuws = 1700; Mean MGD of a standard breast (48-58mm) = 1.19mGy



Number of vieuws = 5048; Mean MGD of a standard breast (48-58mm) = 1.12mGy

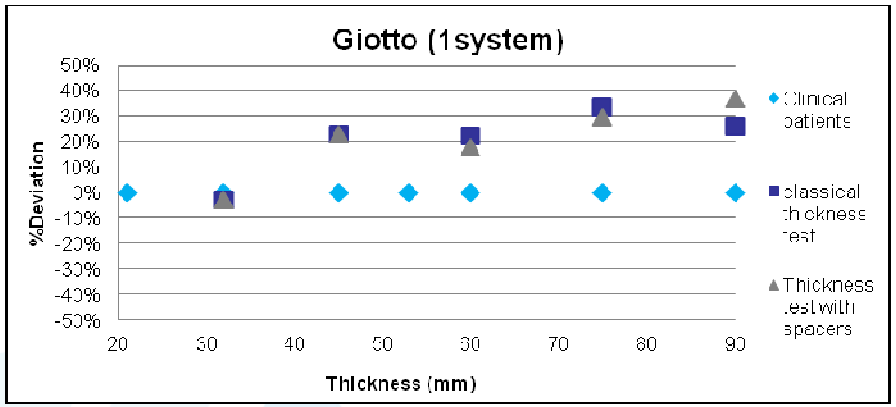


Number of vieuws = 832; Mean MGD of a standard breast (48-58mm) = 1.59mGy

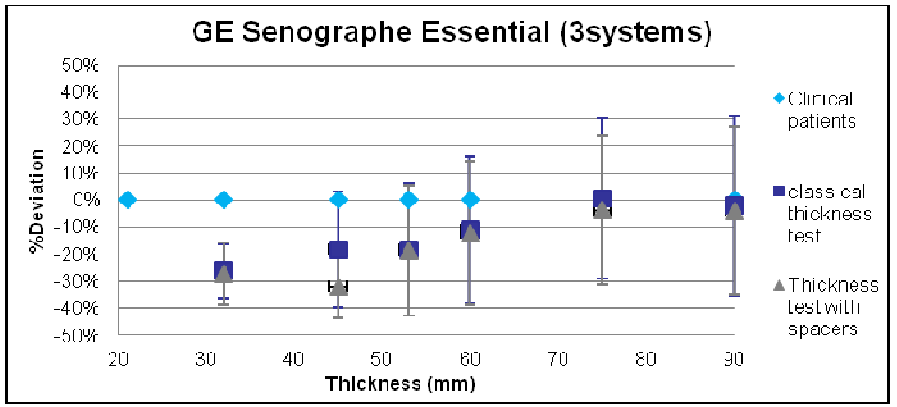


Number of vieuws = 285; Mean MGD of a standard breast (48-58mm) = 1.56mGy

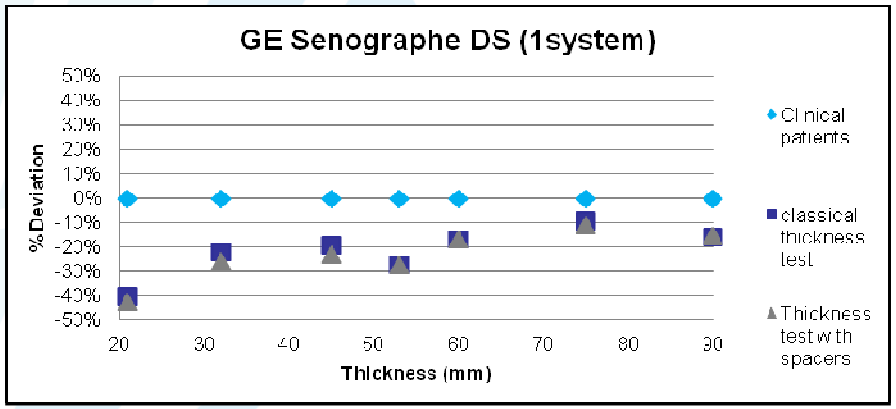
Results



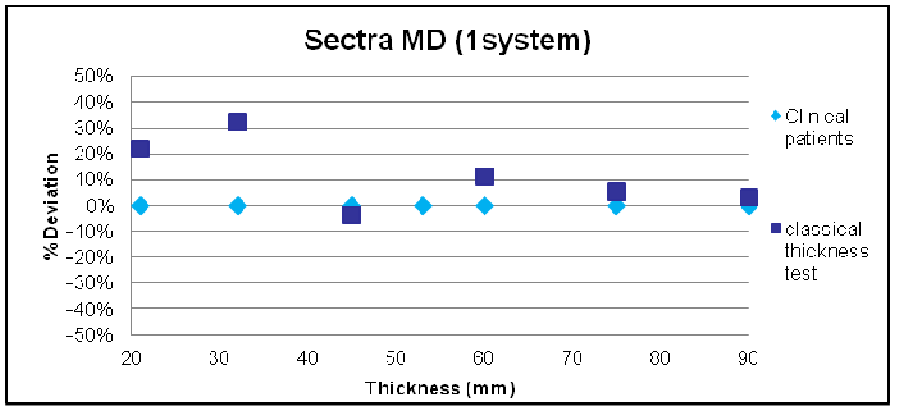
Number of vieuws = 278; Mean MGD of a standard breast (48-58mm) = 1.47mGy



Number of vieuws = 1307; Mean MGD of a standard breast (48-58mm) = 1.44mGy



Number of vieuws = 843; Mean MGD of a standard breast (48-58mm) = 1.41mGy



Number of vieuws = 126; Mean MGD of a standard breast (48-58mm) = 0.58mGy

Discussion

1. Dose data:

- The patient doses with these DR systems are 26% lower than the doses of our previous patient dose survey (film-screen) in the same centers 3 years ago*
- Doses estimated from PMMA plates in general are lower than real patient dose calculations (except Giotto)
- The deviation was the largest for the smallest thicknesses (except Giotto). This can be explained by the fact that PMMA underestimates the density of thin breasts

* Michielsen et al. Radiat Prot Dosimetry 2008; 129(1-3):199-203

Discussion

2. Methodology for the technical dosimetry method

- Siemens Novation: no difference between the thickness test with or without spacers. Probably because there are only 4 AEC programs (the kV choice remains largely the same in large thickness classes)
- Siemens Inspiration, Hologic Selenia and Hologic Dimension: the thickness test with spacers underestimates the patient doses even more. The spacers push the system towards higher tube voltages than in absence of spacers
- On GE systems, the use of spacers makes no difference.
- On Sectra systems, it is not possible to use spacers
- We don’t have enough data for the Giotto system

Discussion

3. Limitations

- The limited number of systems
- We still wonder how the thickness indication should be verified best in practice (where to measure, which phantom to use,…)
- Would the use of slabs with different glandularity estimates improve the correlation between patient doses and physics' estimates?

Conclusion

- Present studies illustrates the need for patient dose monitoring or a further improved physico-technical approach to estimate patient doses for all systems in this study