

Digital mammography review

Image Quality Comparison between GE Healthcare Senographe DS and a 70µm pixel size Selenium-based Mammography System

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Purpose

Compare the image quality and dose of two commercially available digital mammography systems based on phantom measurements.

Method and Materials

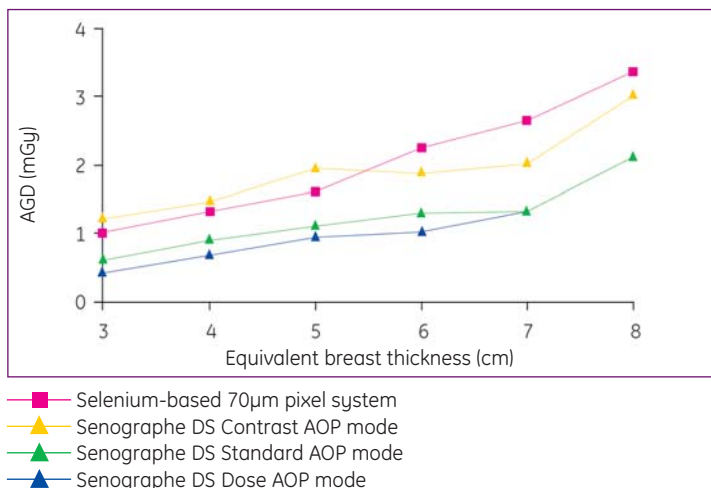
Two commercially available digital mammography systems were evaluated: the Senographe® DS from GE Healthcare and a 70µm pixel size selenium-based system. The automatic exposure modes for these systems were characterized by measuring the ESE (Entrance Skin Exposure) for various thicknesses of acrylic and deriving the AGD (Average Glandular Dose)^[1]. Three fully automated exposure modes are available on the Senographe DS: Contrast, Standard and Dose AOP modes, one mode is available for the selenium-based system. Image quality was evaluated based on CD-MAM contrast detail phantom scoring^[2]. The same Average Glandular Dose was applied on both products for a fair comparison of imaging performance. The CD-MAM phantom was imaged with thicknesses of acrylic equivalent to 3.5 and 7cm breast thickness. The phantom was first imaged on the selenium-based system in fully automatic exposure mode. In order to perform a fair comparison with the same AGD on the Senographe DS, the CD-MAM phantom was imaged by using the Senographe DS AOP Contrast mode (closest to selenium-based automatic mode with respect to dose) and adjusting only the mAs to achieve equivalent AGD with all other exposure parameters unchanged (tube track, filter, kV). Four readers scored the images to derive the Image Quality Figure (IQF) as defined by Thijssen et. al. where higher IQF results in better image quality^[2].

Results

Automatic exposure mode characterization

Figure 1 presents the AGD on the Senographe DS with Contrast, Standard and Dose AOP exposure modes and with the selenium-based automatic exposure mode. The breast

Figure 1: Average Glandular Dose (in mGy) vs. equivalent breast thickness



equivalent thickness ranges from 3cm to 8cm (3cm minimum thickness to allow the ESE measurement). The AGD is derived from ESE and HVL measurements^[1].

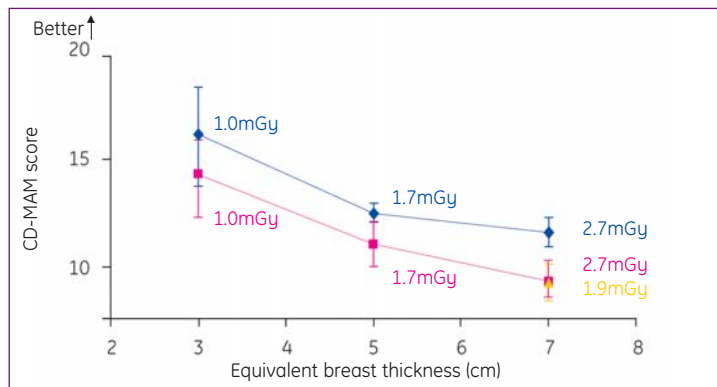
The difference in Average Glandular Dose delivered by the Senographe DS in AOP Contrast mode and the selenium-based system stays between +/- 20 percent except at 7cm where the Senographe DS AOP Contrast mode delivers 25 percent lower dose. The AOP Contrast mode is the closest mode to the selenium-based system automatic mode with respect to dose; the Standard and Dose AOP modes deliver respectively 30 percent to 50 percent and 37 percent to 56 percent lower dose than the selenium-based system.

Image quality comparison

Figure 2 shows the Image Quality Figure for the Senographe DS and the selenium-based system for equivalent AGD. As the Contrast AOP mode is the closest mode to the selenium-based system, the image quality was also assessed with this mode at 7cm equivalent breast thickness where the dose is the lowest compared to the selenium-based system. The CD-MAM phantom and acrylic plates are approximately equivalent to 7cm breast thickness; in this case, the Senographe DS in Contrast AOP mode shows 30 percent dose reduction compared to the selenium-based system (1.9mGy vs. 2.7mGy).



Figure 2: Image Quality Figure



At equivalent dose (AGD)

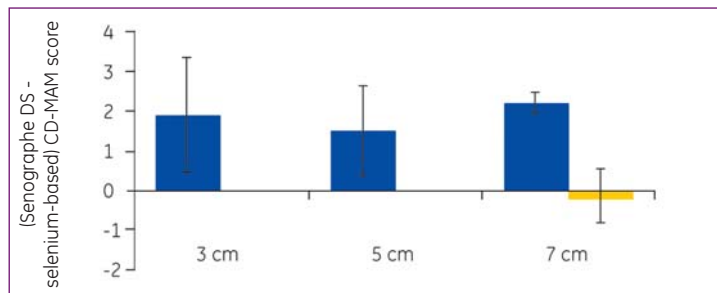
- Selenium-based 70µm pixel system, fully automatic mode
- ◆ Senographe DS same dose as the selenium-based system

With Contrast AOP dose

- ▲ Senographe DS

1.7mGy Average Glandular Dose

Figure 3: Image Quality Figure comparison



- Senographe DS at the same dose as the selenium-based system
- Senographe DS in Contrast AOP mode at 7cm 30 percent less dose than the selenium-based system

Figure 2 shows the average Image Quality Figure and standard deviation for the four readers. Figure 3 presents the difference in Image Quality Figure between the Senographe DS and the selenium-based system at the same AGD for 3.5 and 7cm and for the AOP Contrast mode at 7cm. Figure 3 shows the average and standard deviation for the four readers.

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Figure 3 shows that the Senographe DS image quality is better than the selenium-based system at equivalent dose for 3.5 and 7cm. At 7cm, the Senographe DS Contrast AOP mode delivers an equivalent image quality at 30 percent lower dose.

Conclusion

Based on these results, the image quality of the Senographe DS is better than the selenium-based system at equivalent dose. The Contrast AOP mode of the Senographe DS is the closest mode to the selenium-based system: it delivers between 20 percent more and 25 percent less dose. For the Contrast AOP mode, the largest dose reduction provided by the Senographe DS relative to the selenium-based system occurs around 7cm equivalent breast thickness; then the image quality is equivalent between the two systems with the Senographe DS delivering 30 percent lower dose.

Image quality results from the combination of multiple elements in the image chain, including X-ray tube, exposure management system, detector characteristics, image processing, etc. The pixel pitch may not be the major contributor to image quality as the Senographe DS has a better image quality for the phantom testing with a 100µm pixel pitch when the selenium-based system has a 70µm pixel pitch. In addition, the Senographe DS benefits from a dual track tube (Molybdenum and Rhodium) when the selenium-based system uses only a single Molybdenum track tube. One potential contributor to the better image quality of the Senographe DS may be the tube's Rhodium track that improves signal to noise ratio when compared to the Molybdenum track and is typically used in about 80 percent of the cases on the Senographe DS^[3].

Reference

- [1] D.R. Dance et al., Additional factors for the estimation of mean glandular dose using the UK mammography protocol, Phys.Med.Biol., 2000, Vol. 45, 3225-3240
- [2] Manual Artinis CDMAM-phantom type 3.4, M.A.O. Thijssen, K.R.Bijkerk, UMC Nijmegen and R.J.M. van der Burght, Artinis Medical Systems bv
- [3] Nataliya Shramchenko, Philippe Blin, Claude Mathey, Remy Klausz, Optimized exposure control in digital mammography, SPIE 2004

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