

Image Quality of a Photon-Counting Mammography System Compared to Digital Mammography Based on Amorphous Silicon with CsI-Scintillator

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Abstract. To compare image quality and dose of a photon-counting multi-slit scanner (PC) and a system based on amorphous silicon (aSi), images of the CDMAM 3.4 were taken in standard mode. For 3cm PMMA, the PC used 29kV/11.7mAs, aSi used 27kV/ 50mAs. For 5cm PMMA, PC used 35kV /14.8mAs, aSi used 31kV/ 50 mAs. Exposure was manually increased for PC and lowered for aSi-system. Average glandular dose and an image quality index (IQI) were calculated over the diameter ranges 0.06 - 2.0mm and 0.1-1. In standard mode with 3cm PMMA, IQI for PC was 35% lower than for aSi at 80% lower dose. Increased dose of PC resulted in 13% lower IQI at 57% lower dose. With 5cm PMMA IQI in standard mode was 18 % lower with PC at a 69% lower dose. Increasing the dose of PC resulted a 7% lower IQI at 54% lower dose. In conclusion the PC-system might reduce dose by up to 54% at equivalent image quality, although maximal quality of aSi could not be reached.

1 Background

The aim of this study was to compare the image quality and dose of two full-field-digital-mammography (FFDM) systems based on different technologies: a photon-counting multi-slit scanner (PC) and a system based on amorphous silicon (aSi) with a CsI-scintillator. Both systems are available on the market. The aSi-System (Senographe 2000D, General Electric Medical Systems, Milwaukee, USA) is FDA-approved since 2000; the FDA-approval for the PC-system (Microdose, Sectra, Linköping SE) is pending.

2 Methods and Materials

Images of a contrast detail phantom (CDMAM 3.4, St. Randbout, NL) with 3 and 5cm PMMA-equivalent thickness were taken using the automatic exposure control of each system. For the PC-system imaging parameters at 3cm PMMA were 29kV and 11.7mAs in Standard mode. To increase dose, maximal values of 29kV, 16.1mAs as well as 32kV, 18.4mAs were added manually. For the aSi-system image parameters were 27kV, 50mAs (standard-mode); 25kV, 71mAs (contrast-mode); 28kV and

36mAs (dose-mode). To achieve a comparable dose, the aSi-System was manually lowered to 32kV, 16mAs and 28kV, 16mAs.

At 5cm PMMA, imaging parameters of the PC-system were 35kV and 14.8mAs, and were increased to 35kV, 17.9mAs and 38kV, 16.1mAs. The parameters for the aSi-System in standard mode were 31kV and 50 mAs; dose was manually lowered with 31kV and 11, 16 and 40mAs as well as 35kV and 18mAs. Other beam quality choices might have been made to reduce dose for the aSi system, but have not been tested.

The average glandular dose was calculated for both systems according to Dance [1]. For the PC system spatial dose-distribution is inhomogeneous with lower dose in peripheral than in central parts of the scanned sector, this was considered when calculating average glandular dose. At every parameter setting, 8 images were taken and evaluated with the CDCOM-program. An image quality index (IQI) was calculated over the diameter range 0.06 to 2.0mm (equation 1).

$$IQI = \frac{1}{N} \sum_{i=1}^N \frac{1}{D_i T_i} \quad (1)$$

As all gold disks with large diameters, as well as none of the smallest gold disks were detected with both systems, we also calculated a modified IQI (mIQI) over the diameter-range 0.1 to 1mm. To our knowledge this mIQI is better suited to detect differences between the systems and is less influenced by random errors of the CDCOM-program.

3 Results

3cm PMMA-Phantom

IQI with the aSi-system in standard mode was 34.3 vs. 22.2 (35% difference) with the PC-system, at an average glandular dose of 1.52 mGy and 0.30 mGy (80% difference) respectively (see figure 1). When the dose of the PC-system was manually increased to the maximum of 0.66 mGy, IQI could be increased to 29.8, resulting in a 13% lower IQI at 57% lower dose. The IQI of the aSi-System could not be reached. If the dose of the aSi-system was manually lowered, IQI was 21.4 at 0.50mGy (aSi) vs. 22.2 at 0.30 mGy (PC) a 40% difference in dose at comparable image quality.

Using the diameter ranges of 0.1-1mm the modified image quality index (mIQI) of the aSi-System in standard mode was 42.9 vs. 27.3 with the PC-System or a difference of 36% at 80% lower dose (see figure 2). If the dose of the PC-system was manually increased, mIQI reached up to 36.8 or 90% of the level with aSi, at a 57% lower dose.

5cm PMMA-Phantom

With 5cm PMMA IQI in standard mode was 21.3 for the aSi-System vs. 17.5 for the PC-System at a glandular dose of 1.58 and 0.49 mGy respectively (see figure 3). This translates into a 69% lower dose at 18% lower IQI for a standard patient with 6cm compressed breast. Increasing the dose of the PC system resulted in IQI of 19.8 at