

Differences in dose levels among digital mammography systems

Introduction

Breast cancer screening is a well-established method for reducing mortality in women, because cancers can be detected at an early stage while they are still easy to treat. However, low radiation dose to the breast is important when screening, since healthy women are exposed.¹ Numerous studies comparing digital mammography (FFDM) with screen-film mammography (SFM) and CR plates have been performed, and show the clinical advantage and dose reduction capabilities of FFDM systems.^{2,3,4} With a mammography market dominated by digital systems, studies comparing different models of FFDM are becoming more and more relevant.

This white paper summarizes data from the latest official radiation dose report from Strålsäkerhetsmyndigheten (the Swedish Radiation Safety Authority),⁵ additional data requested from the same authority in 2010,¹⁰ and data from a survey from BreastCheck, the Irish Breast Screening Program.⁶ These studies show a significant difference in dose levels among the different FFDM systems, and that Philips MicroDose demonstrates the lowest average mean glandular dose (MGD) among systems surveyed.

Patient doses in BreastCheck, the Irish Breast Screening Program

An extensive study was carried out based on the data obtained from the Irish National Breast Screening Program, BreastCheck. The aim of the survey was to use the results from a clinical breast dose survey to examine the differences between FFDM models in terms of exposure selection, MGD, and automatic exposure control (AEC) dose contribution. A total of 28 mammography units (11 GE Essential, 10 Hologic Selenia, 7 Philips MicroDose L30) that include a mixture of static and mobile settings were included in the survey. Images were acquired from 2,910 examinations, and included at least 100 examinations from each digital mammography system over a three month period between July and September 2009.⁶

The calculation of MGD was based on the reported exposure parameters from the screening sites and the model by Dance et al.^{7,8,9}

Model	View	Average MGD per exposure (mGy)
Philips MicroDose* L30	CC	0.90 ± 0.01
	OB	0.88 ± 0.01
Hologic Selenia	CC	1.36 ± 0.02
	OB	1.44 ± 0.02
GE Essential	CC	1.39 ± 0.01
	OB	1.52 ± 0.02

Table 1. Average Mean Glandular Dose per exposure according to model (errors represent 95% confidence limits).⁶

Model	Average MGD per examination (mGy)	Examination dose range (mGy)
Philips MicroDose* L30	1.86 ± 0.04	0.71-4.2
Hologic Selenia	2.91 ± 0.06	0.8-9
GE Essential	3.03 ± 0.05	1.3-12.2

Table 2. Examination dose according to model (errors represent 95% confidence limits).⁶

The results of the study show a clear difference in the radiation dose performance of three FFDM systems employed in the BreastCheck Program. When looking at the average MGD per exposure in Table 1, Philips MicroDose clearly has the lowest average MGD for both views, while the average MGD for the Essential was slightly greater than for the Selenia. When looking at the average MGD per examination in Table 2, Philips MicroDose was 1.86 ± 0.04 mGy per examination compared to 2.91 ± 0.06 mGy for Selenia and 3.03 ± 0.05 mGy for Essential respectively. Thus, the average MGD per exam for the Selenia and Essential systems was over 50% higher than for the Philips system.

The conclusion of the study from the Irish BreastCheck Program indicates that the dose range is significantly different among different FFDM systems, and the use of the multi-slit scanning photon counting technology from Philips provides the lowest dose among the digital technologies employed in the Program.

Patient radiation doses in Swedish screening program

The Swedish Radiation Safety Authority controls the screening program, sets the standards for permitted X-ray doses and controls the quality of the mammography systems used in Sweden. The authority publishes a summary of radiation doses for all clinics in the country and also provides more detailed data upon request.

The 2010 report from Swedish Radiation Safety Authority⁵ contains data from 150 mammography units used in 2008 and is described in Table 3. There were 59 FFDM units of which 30 were Philips MicroDose, 21 from GE, and 8 from other manufacturers. 24 CR units and 67 SFM units were used. The dose values given are measured standard doses for one exposure in mGy. The radiation dose data has been collected from the mammography clinics.

Table 3 shows that the exams on Philips MicroDose systems used approximately half of the radiation dose of the other FFDM systems and less than half the dose of the exams using screen-film mammography. The report also states that between 2006 and 2008, the average radiation dose for one exposure in the screening program fell from 1.05 mGy to 0.90, a decrease of about 14%. Furthermore, it concludes that the major part of this reduction can be attributed to the introduction of Philips MicroDose.⁵

Type of system	Number of systems in study	MGD screening, mGy	MGD clinical, mGy
Philips MicroDose*	30	0.48	0.52
GE Senographe	21	0.95	1.02
Other FFDM	8	0.97	1.04
All FFDM	59	0.64	0.87
All CR	24	1.00	0.94
All SFM	67	1.11	1.09

Table 3. Average MGD per exposure in screening and clinical use for various mammography technologies and vendors of FFDM. All data from Leitz et al, Patientdoser från röntgenundersökningar i Sverige – utveckling från 2005 till 2008.⁵

As many new FFDM units have been installed since 2008, a follow-up analysis was made in 2010 with data from the Swedish Radiation Safety Authority. The new data shows a continuation of the same trend in radiation dose reduction due to new digital technology. The Swedish Radiation Safety Authority collected radiation dose data from 62 radiology clinics with a total of 175 mammography units. The data includes information about systems from Hologic, Siemens, Giotto, Philips and GE. 64 SFM units and 24 CR systems are still in use. Figure 1 notes the variation in average MGD among different FFDM systems in the study. The average radiation dose for the Philips MicroDose system was about half that of the other FFDM systems in the survey.¹⁰

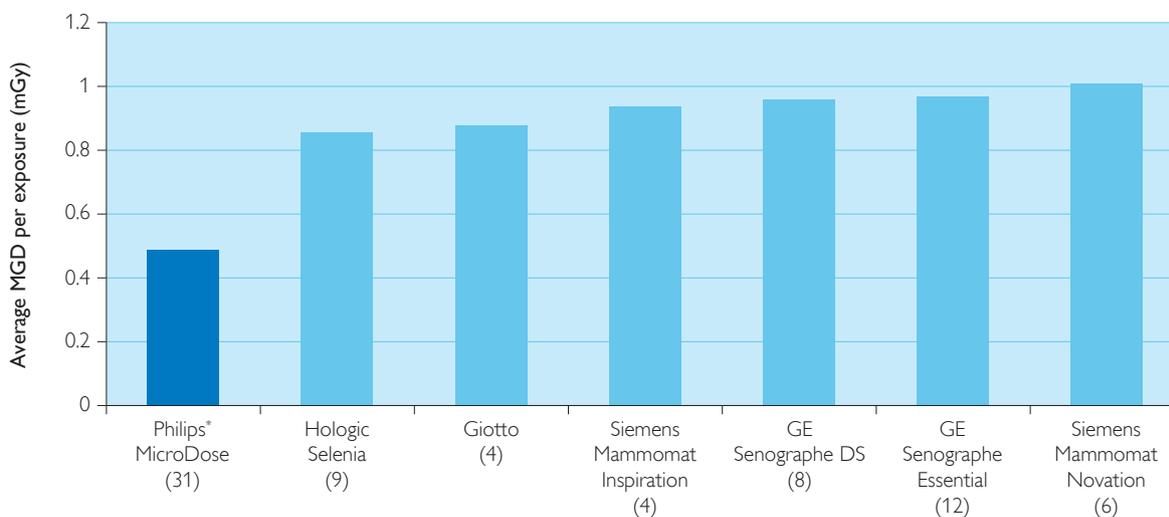


Figure 1: The average MGD per exposure (mGy) for different models of FFDM, in both screening and clinical mammography. The number of units for each model is shown in brackets. All data is from the Swedish Radiation Safety Authority.¹⁰

Discussion

The significantly lower dose levels with the Philips MicroDose system shown in these studies are derived from fundamentally different detector technology. There are several types of detector technologies used for digital systems. One technology uses an indirect conversion of X-rays to electric signals via a scintillator and photosensitive diodes in a thin film transistor (TFT) array (used in the GE Essential and GE Senographe systems). Other systems use a direct conversion technique with TFT arrays coated with a photoconductor such as amorphous selenium, thus eliminating one step but still transforming the X-rays to an analog signal that is later transferred back to digital (used by most FFDM vendors, including Hologic, Siemens and Giotto). Another method, which is used by Philips MicroDose systems, utilizes a direct photon counting silicon detector, which eliminates all the transformation steps. This approach results in a much more efficient detector, while retaining high image quality.^{11,12,13}

Summary

Both studies confirm that the dose reduction advantage of digitalization depends very much on the digital equipment that is used. The study of the Irish Breast Screening Program shows that Philips MicroDose demonstrated the lowest average MGD among the FFDM systems included in the survey. Furthermore, in a study by the Swedish Radiation Safety Authority, the Philips MicroDose system delivered only about half the radiation dose of other FFDM systems included.

* Sectra MicroDose became Philips MicroDose in September 2011.

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