

Patient Dose Measurement in Digital Mammography at King Chulalongkorn Memorial Hospital

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Introduction

Breast cancer remains a leading cause of cancer death among women in many parts of the world. In Thailand, the estimated incidence rate of breast cancer is 17.2 per 100,000 and the number of 12,000 new cases per year expected in 2008¹. Early detection of breast cancer is the key to successful long-term control of the disease and good prognosis. Mammography is the most effective method to produce a high photographic sensitivity image, based on x-ray attenuated through the image receptor and absorbed as a latent image on the recording devices. Most standard mammography includes two views per breast, the craniocaudal (CC) and mediolateral oblique (MLO) views. Mammography requires the highest quality of imaging techniques and fine detail over a wide spectrum of object contrasts in order to successfully identify cancerous growths in their earliest stages of development.

Screen-film imaging receptors have been the standard detector used in conventional mammography. Disadvantages with screen-film mammography are the radiation that the sensitivity for detecting breast cancer is diminished in radiographically dense breasts, which limits its usefulness in high-risk younger women. New developments in detector technology and computers are altering the landscape of mammography imaging. Digital mammography offers the promise of revolutionizing the practice of mammography through its superior dose and contrast performance. For clinical use it is highly effective imaging method for detecting, diagnosing and managing a variety of breast diseases, especially cancer. It is an application where an emphasis on patient dose management and risk reduction is required². The important of digital imaging devices provide a dose index to give an indication of the exposure received by the detector. Nevertheless, the breast tissue has a relatively high sensitivity to some adverse effects of radiation and significant risk of radiation induced carcinogenesis associated with the radiation absorbed dose to the breast.

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The estimation of absorbed dose to the breast is an important part of the quality control of mammographic examination. Knowledge of breast dose is essential for the design and performance assessment of mammographic imaging systems. Minimizing radiation risk is important in general as manifested by the as low as reasonably achievable (ALARA) principle. Radiation risk is a factor in the benefit-risk ratio of mammography³. To quantify the risk from radiation in mammography, the average glandular dose (AGD) is used. AGD is currently accepted as an estimation of the patient dose in mammography. The Food and Drug Administration (FDA), American College of Radiology (ACR) and Mammography Quality Standards Act (MQSA) have established limited of 3.0 mGy for AGD in order to minimize the to the glandular tissue⁴.

Literature Review

Young KC, Burch A, Oduko JM.⁵ reported “Radiation doses received in the UK Breast Screening Programme in 2001 and 2002”. This paper reviews a large representative sample of dose measurements collected during screening in 2001 and 2002 for 53218 films. The average glandular dose was 2.23 mGy per oblique film and 1.96 mGy per craniocaudal film. The MGD to the standard breast was found to vary from 0.76 mGy to 2.29 mGy, with 97% of units below the recommended upper limits of 2 mGy, illustrating the benefit of strict quality control. A reduction in dose of 3% was observed between the age bands 50-54 years and 60-64 years. In most case these higher doses were explained by design of one particular make of X-ray set and its mode of operation. Average doses for oblique views of average sized breasts were fairly well correlated with the dose to

the standard breasts.

Kruger RL, Schueler BA.⁶ Report “A survey of clinical factors and patient dose in mammography”. This report reviews a survey was conducted to estimate the mean glandular dose (MGD) for women undergoing mammography and to report the distribution of doses, compressed breast thickness, glandular tissue content and mammographic technique factors used. From 24471 mammograms, clinical data were collected. Exposure factors for each mammogram were collected automatically onto a floppy disk on each unit. All mammography units were calibrated individually using breast tissue equivalent attenuation slabs of varying glandular content, so the breast glandular content could be estimated on the basis of exposure factors and compressed breast thickness. The MGD was estimated for each mammogram based on the normalized glandular dose and calculated entrance exposure in air. The survey found a median MGD of 2.6 mGy. The median breast glandular tissue content was 28% and the median compressed breast thickness was 5.1 cm. Also, patient attenuation data were converted to equivalent BR12 and acrylic thickness to help determine appropriate phantom thickness required for mammography units automatic exposure control performance assessment.

Purpose

To determine the entrance skin exposure (ESE) and the average glandular dose (AGD) per exposure with grid for each projection of mammography service at King Chulalongkorn Memorial Hospital.

Material

The mammography equipment is a Selenia Dimensions, manufactured in 2009 by HologicLorad verified by department of medical science, Thailand in 2011 and the

study involved 200 patients.

Method

Retrospective study of patient dosimetry from a digital mammography system involving routine medio lateral oblique (MLO) and cranio caudal (CC) views acquired on the right and left breasts of female patients as in figure 1A, 1B, 1C and 1D.

Result

The average range, minimum and maximum values of the following parameters such as the tube voltage

(kVp), the tube current-time (mAs), compressed breast thickness (CBT) were collected. The entrance skin exposure (ESE) and average glandular dose (AGD) were determined from 200 mammography female patients. The results are displayed in Table 1. The average glandular dose (AGD) was 1.78 mGy for (RCC), 1.77 mGy for (LCC), 1.86 mGy for (RMLO) and 1.98 mGy for (LMLO) respectively. The average entrance skin exposure (ESE) was 6.79 mGy for (RCC), 6.83 mGy for (LCC), 7.15 mGy for (RMLO) and 7.83 mGy for (LMLO) respectively.

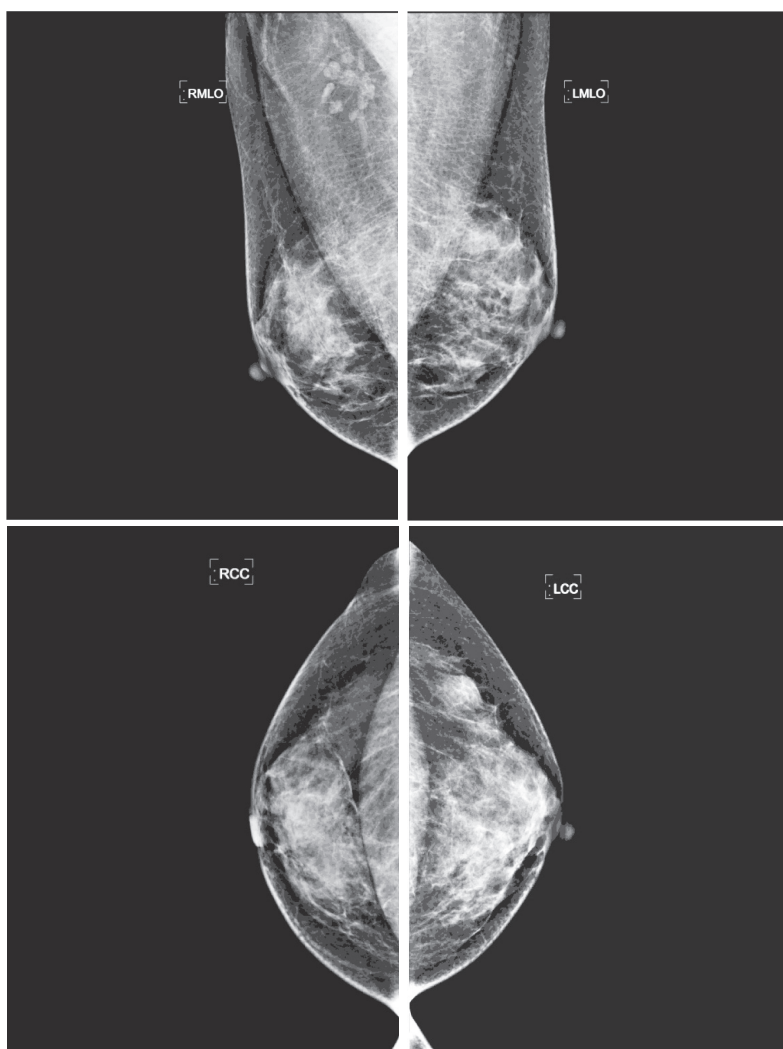


Figure 1 A Right MedioLateralOblique (RMLO) B Left MedioLateral Oblique (LMLO) C Right CranioCuadal (RCC) D Left CranioCuadal (LCC)

Table 1 Data collected from 200 female patients at the digital mammography systems, KingChulalongkorn Memorial Hospital

	(RCC)					(LCC)				
	CBT(mm)	kVp	mAs	AGD(mGy)	ESE	CBT(mm)	kVp	mAs	AGD(mGy)	ESE
Mean	54.49	29.42	141.16	1.78	6.79	55.42	29.47	135.51	1.77	6.83
Min	14	25	61	0.73	1.79	17	25	18	0.66	1.28
Max	82	32	372	4.18	18.15	99	35	476	7.89	36.04

	(RMLO)					(LMLO)				
	CBT(mm)	kVp	mAs	AGD(mGy)	ESE	CBT(mm)	kVp	mAs	AGD(mGy)	ESE
Mean	55.20	29.55	145.20	1.86	7.15	56.76	29.84	150.79	1.98	7.83
Min	21	25	63	0.79	1.96	22	21	63	0.77	1.87
Max	86	34	405	5.07	21.18	102	49	397	6.14	27.68

Discussion and Conclusion

The average glandular dose can be estimated using a Perspex phantom exposed at the settings normally used in clinical practice for a breast of the size and composition similar to that of the standard breast. The method involves the determination of incident air kerma for the correct exposure and the half value layer of the x-ray beam. The tube output per mAs should first be measured and then multiplied by the conversion factor of Perspex phantom for the standard breast. This method was used at the commissioning and reference testing of the mammography, ESE and AGD are displayed on the computer screen after exposure for this study. The mammogram was performed using the grid. The determination of patient dose in Digital mammography at King Chulalongkorn Memorial Hospital revealed that the mean AGD per image is 1.78 mGy for RCC view, 1.77 mGy for LCC view, 1.86 mGy for RMLO view and 1.98 mGy for LMLO view. The ESE and AGD from MLO views were greater than those from the CC views for the right and left sides because the MLO CBT is slightly thicker than

the CC CBT. Overall, 91.41% of CC view and 89.14% of MLO view were lower than the reference level of 3.0 mGy. The result on ESE was comparable to the ESAK (entrance skin air kerma) value published in IAEA TECDOC 1447 of 6.4+ 2.6 mGy after the QC procedure⁷. The AGD is less than the limiting values of 3.0 mGy per exposure with grid 1.5 mGy without grid.

The AGD per image is significantly different between the CBT as classified by glandular content groups. It increases with increasing CBT, while decreases with increasing age. The results represent the digital mammography examination at one department is capable of achieving acceptable dose levels for patient safety. The mAs is significant affect on the AGD. The AGD in the digital mammography system is related to auto filter mode of automatic exposure control system, which adjust the radiation dose, as defined by the mAs product, based on the patient thickness. These are useful for the patients that the risk of cancer induction can be considered. It is an important for radiologists and technologist to increase the awareness in the study for the patient especially the

adult one.

In conclusion the optimization for the patient could be obtained by implementation the quality control program of the x-ray system and by determining the patient dose for both ESE and AGD with other parameters such as kVp, mAs, CBT, type of target, filter and the compressed force. The patient dose should be compared with the reference level and the dose limit. The image quality should be maintained with dose optimization for the patients of every case.

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