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Determination of Scatter Radiation Round Three Different Models of Mammography Unit

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ABSTRACT

Purpose: this study was carried out to determine the amount of scatter radiation around three different models of digital mammography units may contribute to shielding calculations.

Objectives: measuring and comparing for scattered radiation at four orientations (4 x 90º=360º) round three mammography models.

Materials and methods: RADOS (RDS-120 Universal Survey Meter) device was used to measure scatter radiation at four orientations round three types of mammography digital models NM-GA, Liyum, and Mammomat. These orientations are backward, forward, left lateral, and right lateral. All measurements are taken in Craniocaudal projection.

Results: backward orientation has highest and right lateral has lowest intensity of scatter radiations when three models of digital mammography were used. Mammomat model with backward orientation was at highest 6.5µSv of intensity and NM-GA model at lowest intensity of 1.1 µSv from right lateral orientation.

Conclusions: The obtained measurements of scatter radiation at four different orientations may be used in a shielding calculation when NM-GA, Liyum, and Mammomat of mammography models are used.

KEYWORDS: mammography, orientations, radiation, scatter.

1. INTRODUCTION

Because of the overall increase in the use of medical ionizing radiation, many patients and their physicians are appropriately concerned about individual radiation dose and specifically concerned about the risks of radiation from mammography. Although the dose absorbed by the breast and adjacent organs during mammography is a small component of the lifetime accumulated dose from medical imaging and other sources, the popular press tends to emphasize the radiation risk of mammography, particularly screening mammography[1]. Referring to physicians, regardless of their area field of practice, underestimate both dose and potential effects [2]. Air kerma of effective dose as 1 Sv/Gy is conservatively high in the mammography energy range and overestimate the barrier thickness [3].Physicians are obligated to balance the risks and benefits of various medical procedures while keeping the patient informed of risk-to-benefit ratios. This is particularly important for women of child-bearing age and pregnant women. Knowledge of the scatter radiation dose from screening mammography is important because it enables health care providers to better educate women regarding the radiation risks associated with mammography[4]. Although direct radiation dose measurements to the breast and predicted radiation-induced breast cancers from mammography have been well documented, doses to other organs from scatter radiation have not been directly measured but have been estimated through computer simulations and the use of phantom models [5]. In mammography units, the primary beam is intercepted by the image receptor. Guidelines allow only slim strips of the primary beam to interfere with the image receptor assembly along the chest wall edge of the beam [6].

This radiation is reduced to insignificant degree by the patient, and consequently, only scattered radiation must be in account for radiation protection purposes in mammography unit. Moreover, it is hypothesized that the diffuse radiation from the patient is the main source of secondary radiation, given the negligible leakage intensity observed in mammography[8]. Knowledge of radiation safety during an imaging study is of great interest to radiologic technologists, radiologists, referring physicians, and patients. The magnitude of the risks from low doses of radiation is one of the central questions in radiologic protection and is relevant when discussing the justification for diagnostic medical exposures. The intensity of x-ray depends on the kvp applied to the x-ray tube, x-ray field size, and scattering angle[7].

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Kilo-voltage peak (kvp)and tube current–time(mAs) in the automatic selection of exposure operation are factors used in stander mode[8]. For the 30 and 35 kvp acquisition, the scatter-to-primary-ratio and scatter was measured to demonstrate non isotropic distribution of the scattered radiation around a DBT system, with two strong peaks around 25° and 160°[9]. This study was carried out to measure the scattered radiation at four orientations (4 x 90^o=360^o) round the mammography.

2. MATERIALS AND METHODS

2.1 Mammography and Experimental set-up

Three models of digital mammography devises NM-GA, Liyum, and Mammomat were used with specific specifications quoted from Manufacture Company as shown in Table 1. Filtration and absorption in specifications are fixed parameters in three models used.

Table 1: Specifications of digital mammography models used in experimental

Specifications model	NM-GA	Liyum	Mammomat
Manufactured	Neusoft medical system	Corman (Italy)	SIEMENS
Serial No	G-A-15060003	1 Lil Hf P/ 231/co	55643
Manufactured date	June 18, 2015	May 2009	2004
Power supply	220- 250-volt 50/60 Hz	220–240-volt 50/60 Hz	380–480-volt 59/60 Hz
Filtration	0.4 mm	0.5 mm	0.4 mm
Absorption	6.4 kv A	6.6 kv A	5.4 kvA

Each digital mammography used in the experiment has four orientations backward, forward, left lateral, and right lateral. These orientations involved all scatter radiation round digital mammography devices. Scatter radiation was measured at a distance of 1 m from the centre of the image receptor (IR) stands for various orientations ranging from 0° to 360^0. Each measurement of scatter radiation was at vertical angle 90^0 as shown in figure 1.

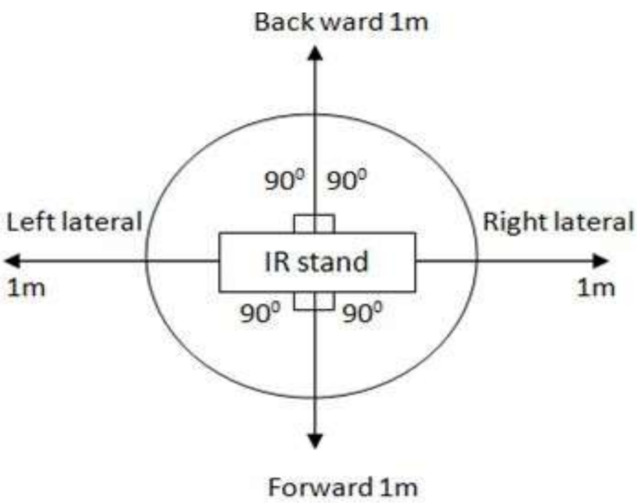

Figure1: Experimental set –up used to measure scatter radiation at four orientations.

2.2 Survey Meter:

Measurements of the scatter radiation intensity in Craniocaudal projection at different orientations were achieved by RADOS (RDS-120 Universal Survey Meter, manufacturer: RADOS technology OY Finland,S.No: 20563054 - 990372) with specifications in Table 2. These measurements involved all scatter radiation that could be presented round IR stand. The results have been taken from three times and averaged by measurements.

Table 2: Specification of RDS-120 Universal Survey Meter

Radiation detected	Gamma and x-rays, 50 keV… 3 MeV. Beta radiation with an external probe
Dose measurement range	0.01 µSv … 10 Sv or 1 µrem...1000 rem
Energy range	50 keV… 3 MeV, within the range of0.05 µSv/h … 10 mSv/h or 5 µrem/h...1 rem/h80 keV… 3 MeV, within the range of10 mSv/h… 10 Sv/h or 1 rem/h...1000 rem/h
Power supply	3 alkaline batteries (IEC LR6), +12 V DC external battery adapter (optional) or AC adapter (optional)

2.3 Measurements:

For this study, digital mammography model systems were operated in manual mode, which allowed selection of kilo voltage peak (Kvp), tube milliampere second (mAs), and Projection Table 3. These systems were subjected to routine quality assurance during the period of this study in accordance with the recommendations of the European Guidelines for breast cancer screening and Diagnosis[9].

Table 3: Exposure factors used in experimental

Exposure factors	Mammography model		
	NM-GA	Liyum	Mammomat
Kvp	35	35	35
mAs	20	20	20

4. RESULTS AND DISCUSSION:

It is evident from results that scatter radiation varied considerably across three models of mammography systems and orientations Table 4.

Table 4: Scatter radiation at four orientations round various mammography models

Orientation	Scatter radiation (µSv)		
	NM-GA	Liyum	Mammomat
Backward	1.7	4.2	6.5
Forward	1.3	3.6	4.4
Left lateral	1.2	1.5	2.8
Right lateral	1.1	1.4	1.6

According to results, intensity of scattered radiation was presented when three models of digital mammography NM-GA, Liyum, and Mammomat were used as shown in figure 2.

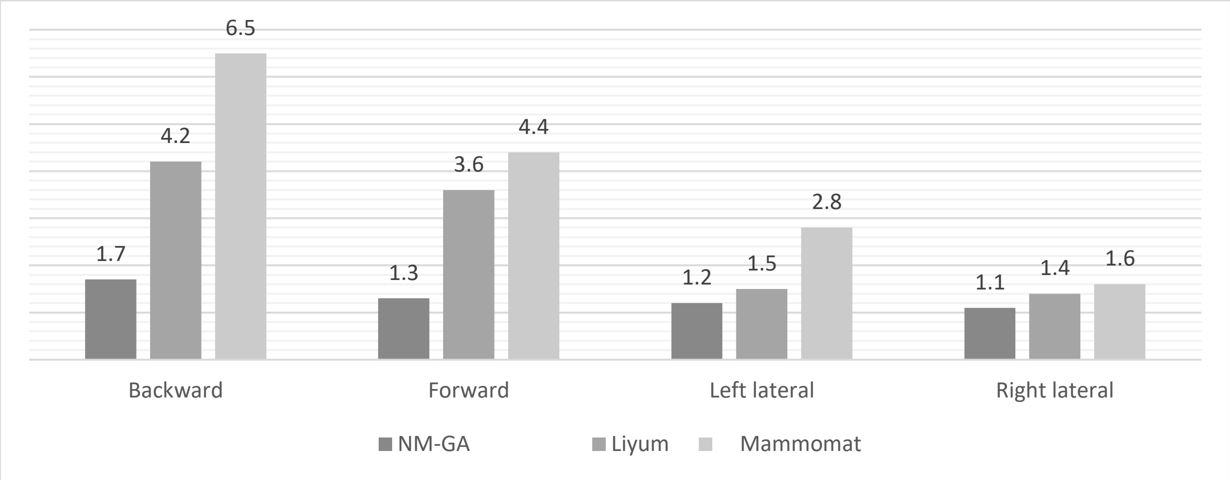

Figure 2: Intensity of scattered radiation at four orientations (backward. Forward, left lateral. And right lateral) round three different mammography models.

The columns in figure 2 give indications of this variation round the IR stand. Scatter radiation appeared at highest intensity when Mammomat model was used compared to Liyum and Mammomat models. Regardless of mammography type models, the scatter radiation in backward orientation was at highest intensities. This highest intensity was of 6.2 µSv measured from Mammomat model. On other hand, the intensity became at lowest value of 1.1 µSv in right lateral orientation when NM-GA model was used.

For NM-GA model, the results showed scatter radiation decreased 1.7 µsv, 1.3 µsv, 1.2 µsv, and 1.1 µsv from backward, forward, left lateral to right lateral orientation respectively. For Liyum model, scatter rdiation was found at aminimum of 1.4 µsv in right lateral orientation while it was at a maximum of 4.2 µsv in backward orientation. Otherwise, scatter radiation for Mammomat model was a maximium of intensity at 6.5 µsv in backward orientation and beacame a minimium at 1.6 µsv in right lateral orientation. Notice that in all mammography models used in experimental, the maximum scatter radiation was from Mammomat model particullary in backward orientation.

5. CONCLUSIONS

The distribution of scattered radiation varies with orientation for three mammography models which used. It is clearly shown scatter radiation from NM-GA model has lowest intensity at right lateral orientation and Mammomat model has highest intensity partically at backward orientation.

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