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RESEARCH ARTICLE

Assessment of Mean Glandular Dose (MGD) Received in Mammography Examination in Khartoum

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Abstract

Diagnostic X-ray examinations play an important role in the health care of the population. These examinations may involve significant irradiation of the patient and probably represent the largest manufactured source of radiation exposure for the population. This study was performed in Dar Elalag hospital and Elkawati Hospital. This study performed to assess the Mean Glandular Dose (MGD) received in mammography examination using Robson's parametric method and Dance's additional factors. The parameters were recorded in this study were patient's age, breast thickness, tube target filter and the exposure factors (mAs and kVp). The results of MGD values calculated showed that patient exposure was were significantly lower than the standard dose determined by IAEA. The mean MGD values calculated were 1.59 $\pm$ 0.17 ($p<0.01$) and 1.63 $\pm$ 0.22 ($p<0.01$) for Craniocaudal and Oblique projections, respectively.

INTRODUCTION

Radiological examination of the breast considers as an essential part of the modern multidisciplinary approach to effective investigation and management of breast disease. The more widespread use of X-ray mammography in breast cancer screening programs have been accompanied by further development of both invasive and non-invasive radiological techniques used for establishing the diagnosis of palpable and non-palpable lesions (Abdallah, 2011). The standard techniques used for breast imaging are screening, film X-ray mammography and real-lime ultrasound. Other new techniques, either which are under development or for which the indications for use is being evaluated include MRI, color Doppler and contrast ultrasound, scintimammography and digital mammography. High quality mammography requires efficient equipment and trained radiologic teams. All mammographs need approximately the same designed generators (tungsten anode system, Molybdenum target or rhodium target for dense breast photo-timing, small focal spot sizes) but there are two types of signal reception: Classical Screen Field Mammography (SFM) that requires scatter-reducing grid, and high definition films, and more recently Full field digital mammography (FFDM): this technique is divided in CR (Computed radiology) where ERLM Screens receive the signal that is then read by laser spot or DR (Digital Radiology) ; in this former the detector transmits the signal to a numerical reading system. FFDM permits acquisition, storage and facilitates the comparison. It has been demonstrated that FFDM offers quite the same accuracy in terms of detection and diagnosis of breast pathology, especially for the examination of dense breast tissue and for the microcalcifications. FFDM and SFM offer the same specificity (almost 92 %) and quite the same sensibility except in the subgroup of dense breasts (BIRADS 3-4) of women under 50 years old. FFDM is now also available for the Breast cancer screening, subject to quality control as in SFM. Physical examination should always precede mammography. Mammography in every technique uses compression of the breast between parallel rigid plates, permitting projection of the breast unto the surface film. The dose delivered to the breast should remain within acceptable limits and seems to be lower with FFDM. Usually craniocaudal and oblique views of both breasts are obtained. For the craniocaudal view the breast must be well drawn, centered, the nipple perpendicular projecting out of the breast. The oblique view compresses the breast along a 45 to 60axis (the beam parallel to the pectoralis muscle extending from the axilla to the lower quadrants of the breast) and projects more breast tissue than straight lateral view. Additional views are obtained completing the check: Mediolateral side view permits to localize an abnormality. The mediolateral or lateromedial access will be chosen depending if the image is in the outer or in the inner quadrant (minimal distance between the image and the receptor); the magnified views in SFM and high resolution, if possible magnified views in FFDM complete microcalcifications analysis. For the examination of a densification or a mass, it could also be useful to rotate the breast or to use a small compression plate to differentiate normal breast tissue from a true mass. The analysis of microcalcifications requires magnified views in high resolution to identify the morphology and shape of the group. Some techniques are developing like Digital Breast Tomosynthesis: In Tomosynthesis, the breast compressed in the same manner but the X-ray tube allows the acquisition of many low dose images rather than only one on FFDM. Then these slices reconstructed by using 3D software. This new technique is in evaluation for analysis of densification and geometry of clusters of micro calcifications [1].

Material and Methods

A mammographic X-ray generator (SIEMENS, Mammomat 3000) with tube potential in the 23–30 kV range employed in this study. It has the focus-to film distance (FFD) of 650mm and three anode/filter combinations: molybdenum/molybdenum (Mo/Mo), molybdenum/rhodium (Mo/Rh) and tungsten/ rhodium (W/Rh). The feature of automatic exposure control (AEC) used in routine mammographic examinations. Automatic selection of appropriate anode/filter/tube potential combination based on the compressed breast thickness, which correlates to the position of compression plate prior to the exposure. Four anode/filter/tube potential combinations for various compressed breast thicknesses. Our study population consisted of 50 women in whom additional 60° films after standard 45° films obtained. Additional 60°films obtained for clarifying suspect or indeterminate focal lesions or microcalcifications. Additional oblique films did after the informed consent (we explained to our patients the potential benefit of early cancer detection versus a small carcinogenic risk related to the additional exposure). All our patients were ≥40 years old. Women with breast implants, prior lumpectomy and radiotherapy excluded from the study. By using a computer model, we produced data that allow the calculation of tube output and half value layer for the range of clinically encountered conditions. To do that, the following equations are used.

$$\log_{10}(ESAK) = n\log_{10}(kV)+\log_{10}(A) \qquad (1)$$

$$HVL = a(kV)2+b(kV)+c \qquad (2)$$

Where calculated values for a, **b, n** calculated using tabulated values.

We calculated mean glandular breast dose using Dance equation:

$$MGD = K\cdot g \qquad (3)$$

Where **K** was the Entrance Surface Air Kerma, and **g** a conversion factor depending on HVL, assuming a 50% glandular/adipose tissue composition in breast.

$$MGD = K\cdot g\cdot c\cdot s \qquad (4)$$

Where **K** and **g** are the same as before, the factor **c** corrects for any difference in breast composition from 50% glandularity and the factor **s** corrects for any difference from the original tabulation due to the use of a different x-ray spectrum. S-factors tabulated for the following spectra: Mo-Mo, Mo-Rh, Rh-Rh, Rh-Al, and W-Rh.

The average glandular dose (D) to a typical breast of thickness and composition equivalent to the thickness of PMMA tested is calculated by applying the following formula.

$$MGD = K\cdot g\cdot c\cdot s \qquad (5)$$

Where K is the entrance, surface air kerma (without backscatter) calculated at the upper surface of the PMMA. The factor g, corresponds to a glandularity of 50% and the c-factor is given for typical breasts in the age range 50 to 64.

Result and Discussion

The study was performed on 50 women aged between 44 and 56 years (mean age was 50.4 ± 5.5 years), in whom additional Craniocaudal projection 60° films after standard Craniocaudal projection 45°films were obtained. The mean thickness of the compressed breast was significantly lower with an angle of 60° than with an angle of 45° (Table 1). The correlation between the thickness of the compressed breast and mAs applied showed in (figure 1).

Table 1. Thickness of compressed breast (mm) Craniocaudal projection 45° versus 60°

Mammographic Mediolateral oblique view	**45°**	**60°**
Mean	50.6	49.8
Standard deviation	12.3	12.0
Significant	p<0.01	

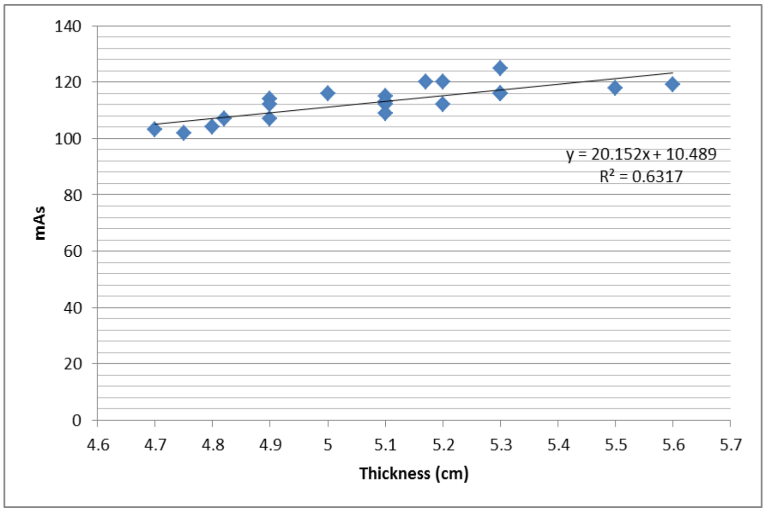

Figure 1. Correlation between the compressed breast thickness and tube current rate (mAs) for Craniocaudal projection 60° film ($p<0.01$)

The mean time-current product (mAs values) was significantly lower with an angle of 60° than with an angle of 45° (Table2).

Table 2. Time current product of Craniocaudal projection 45° versus 60°

Time current product	**45°**	**60°**
Mean	113.5	110.8
Standard deviation	6.4	6.1
Significant	p<0.01	

The mean kilo-voltage applied was significantly lower with an angle of 60° than with an angle of 45° 27.3 *versus* 28.2, p<0.01) (Table 3).

Table 3. Kilo-voltage of Craniocaudal projection 45° versus 60°

Time current product	**45°**	**60°**
Mean	27.3	28.2
Standard deviation	1.0	1.9
Significant	p<0.01	

The mean exposure was significantly lower with an angle of 60° than with an angle of 45° 0.67 *versus* 0.78, p<0.01) (Table 4).

Table 4. The exposure of Craniocaudal projection 45° versus 60°

Time current product	**45°**	**60°**
Mean	0.76	0.78
Standard deviation	0.02	0.03
Significant	p<0.01	

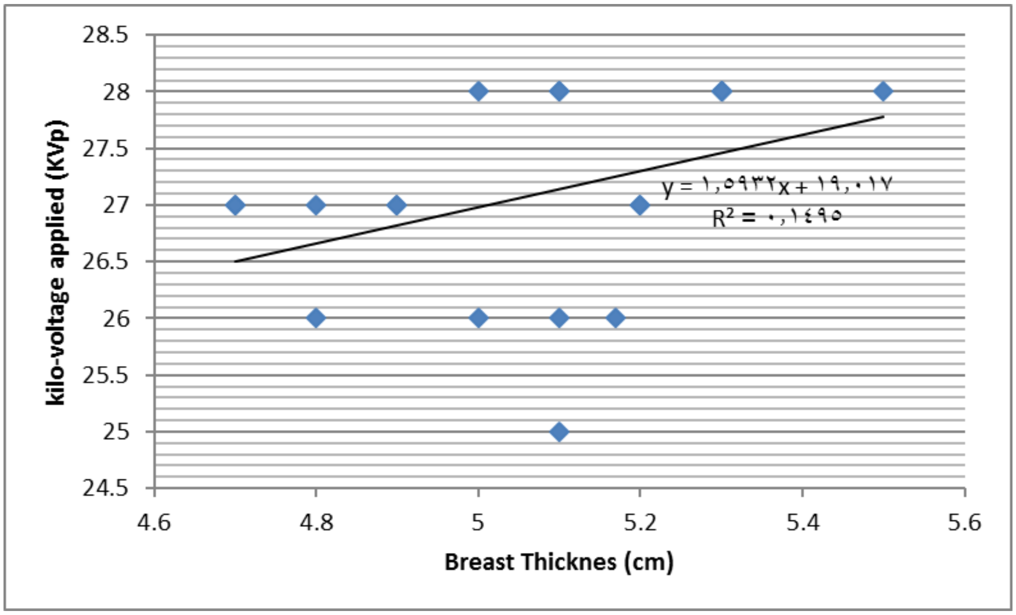

Figure 2. Correlation between the compressed breast thickness and Kilo-voltage applied (KVp) for Craniocaudal projection 60° film (p<0.01)

The average spatial resolution was insignificantly better with an angle of 60° than with an angle of 45°. There was no difference in the average contrast resolution. (Table 5)

Table 5. The spatial resolution of image of Craniocaudal projection 45° versus 60°

Time current product	**45°**		**60°**	
	Scale (0-3)	Contrast resolution	Scale	Contrast resolution
Mean	1.66	1.41	1.59	1.48
Standard deviation	0.05	0.09	0.03	0.09
Significant	p<0.01			

The estimated ESAK (mGy), ESD (mGy), MGD (mGy) and Corrected breast thickness (cm) showed in table 6 (p<0.01).

Table 6. The measured dose of Craniocaudal projection 45° versus 60°

Measured dose	**ESAK (mGy)**		**ESD (mGy)**		**MGD (mGy)**		**Corrected breast thickness (cm)**
	45°	**60°**	**45°**	**60°**	**45°**	**60°**	
Mean	8.9	***8.4***	***9.6***	9.3	1.7	2.2	5.6
Standard deviation	1.3	1.2	1.98	2.1	0.3	1.1	1.3
Significant	p<0.01						

Table 6. The measured dose of Craniocaudal projection 45° versus 60°

Author	**Subjects**	**Mean Compressed breast thickness (mm)**	**Conversion factors used**	**Mean MGD (mGy) (+1 SD) or in range in MGD (mGy)**
Thilander et al. (1992)	1350	50 ± 13	Rosen et al. (1985)	1.2 +0.5
Whall and Roberts (1992)	130	55 ±13	Dance (1990)	2.0

Moran et al. (1994)	345	52 ±13	Dance (1990)	0.4 -5.4
Bulling and Nicoll (1995)	310	49 ± 13	Dance (1990)	0.7 -8.5
Klein et al. (1997)	1678 945	56 ±13 51 ± 13	Klein et al. (1997)	1.6 + 0.6
Young and Ramsdale (1997)	287	56 (22-108)	Wu et al. (1991)	2.1 + 0.7
Dong et al. (2002)	120	37 ±10	Dance (1990)	1.7
The study	50	51 ±12	Dance et al. (2000)	1.62 + 0.5

Conclusion:

Estimation of mean-glandular dose (MGD) and Entrance surface dose ESD have been studied in recent years due to the risks of radiation-induced carcinogenesis associated with the breast radiology. This study performed in Dar Elalag hospital and Elkawati Hospital. This study performed to assess the Mean Glandular Dose (MGD) received in mammography examination using Robson's parametric method and Dance's additional factors. The parameters were recorded in this study were patient's age, breast thickness, tube target filter and the exposure factors (mAs and kVp).

In a previous study 23 the authors estimated the breast irradiation indirectly recording exposure parameters and found differences in favor of 60°films which agrees with the results of this study. In both studies, fixed kVp protocol was used: the tube voltage was constant and the variable breast thickness was compensated by mAs values. Dong et al, (2002) studied the patients dose in fixed kVp protocol versus variable kVp protocol and found a lower radiation dose for thicker breast when variable kVp protocol was used, with a small reduction in image quality.15 In spite of this, we used fixed kVp protocol because we consider that the patients dose reduction should not interfere with the image quality.

We conclude that 60°-films were obtained with better breast compressibility comparing to 45°-films, which results in lower time-current product and exposure whereby the image quality was the same or even better.

References

Beckett, J.R., Kotre, C.J., 2000. Dosimetric implication of age related glandular changes in screening mammography. Phys. Med. Biol. 45, 801–813.

Bower, M.W., Hintenlang, D.E., 1998. The characterization of a commercial MOSFET dosimeter system for use in diagnostic X-ray. Health Phys. 75, 197–204.

Bulling, S.M., Nicoll, J.J., 1995. Level and distribution of the radiation dose to the population from a mammography screening programme in New Zealand. Radiat. Prot. Dosimetry 57, 455–458.

Butson, M.J., Rozenfeld, A., Mathur, J.N., Carolan, M., Wong, T.P., Metcalfe, P.E., 1996. A new radiotherapy surface dose detector: the MOSFET. Med. Phys. 23, 655–658.

Dance, D.R., 1990. Monte Carlo calculation of conversion factors for the estimation of mean glandular breast dose. Phys. Med. Biol. 35, 1211–1219.

Dance, D.R., Skinner, C.L., Carlsson, G.A., 1999. Breast dosimetry. Appl. Radiat. Isotopes 50, 185–203.

Dance, D.R., Skinner, C.L., Young, K.C., Becktt, J.R., Kotre, C.J., 2000. Additional factors for the estimation of mean glandular breast dose using the UK mammography dosimetry protocol. Phys. Med. Biol. 45, 3225–3240.

Dong, S.L., Chu, T.C., Lan, G.Y., Wu, T.H., Yeh, Y.H., Mo, S.P., Lee, J.S., (In press). Characterization of high sensitivity metal oxide semiconductor field effect transistor dosimeters system and LiF:Mg, Cu, P thermoluminescence dosimeters for use in diagnostic radiology. Appl. Radiat. Isotopes, in press.

Faulkner, K., Law, J., Robson, K.J., 1995. Assessment of mean glandular dose in mammography. Br. J. Radiol. 68, 877–881.

Gentry, J.R., DeWerd, L.A., 1996. TLD measurements of in vivo mammographic exposures and the calculated mean glandular dose across the United States. Med. Phys. 23, 899–903.

Tabar, L., Dean, P. B. (2001) Teaching Atlas of Marmmography, 3rd edn. Stuttgart. Thieme.

Stuhrmann, M., Aronius, R., Schietzel, M. (2000) Tumor vascularity of breast lesion: potentials and limits of contrast-enhanced Doppler sonography. American Journal of Roenigenology, 176, 1 585-1589.

Wallis. M. G., Walsh, M. T., Lee, J. R. (1991) A review of false negative mammography in a symptomatic population. Clinical Radiology, 44. 1 3-15.

Heywang-Kobrunner, S. (1990) Contrast Enhanced MRI of the Breast, 2nd cdn. Berlin: Springer.

ICRP (International Commission on Radiological Protection), 1991. Recommendations of international commission on radiological protection. ICRP Publication 60. Ann. ICRP 21(1–3), 5–9.

IPSM (Institute of Physical Science in Medicine), 1994. The commissioning and routine testing of mammographic X-ray system.

IPSM Report 59, 2nd Edition. IPSM, New York.

Klein, R., Aichinger, H., Dierker, J., et al., 1997. Determination of average glandular dose with modern mammography units for two large groups of patients. Phys. Med. Biol. 42, 651–671.

Mor!an, P., Chevalier, M., Va*n! o, E., 1994. Comparative study of dose values and image quality in mammography in the area of Madrid. British Journal of Radiology 67, 556–563.

Quach, K.Y., Morales, J., Butson, M.J., Rosenfeld, A.B., Metcalfe, P.E., 2000. Measurement of radiotherapy X-ray