FAMPO
FEDERATION OF AFRICAN MEDICAL PHYSICS ORGANIZATIONS

African Journal of Medical Physics
2020; 3(1): 10-13. doi: 10.

Research Paper

# Estimation of Mean Glandular Doses for Patients Undergoing Mammography Examination in Some Selected Centers in Lagos State, Nigeria

Joshua Josephine[1], Nzotta Chukwuemeka Christian[2], Joseph Dlama Zira[3,✉], Abubakar Matthew Garba[4], Mohammed Sani Umar[3], Abdullahi Hassan Abdullahi[5], Bature Silas Shem[3]

1. Department of Radiography, University of Lagos, Lagos State, Nigeria.
2. Department of Radiography, Nnamdi Azikiwe University, Akwa, Anambra State, Nigeria.
3. Department of Radiography, Bayero University, Kano, Kano State, Nigeria.
4. Department of Radiography, University of Maiduguri, Maiduguri, Borno State, Nigeria.
5. National Agency for Science and Engineering Infrastructure, Idu Industrial Area, Abuja, Nigeria.

✉ Corresponding author: Dr. Dlama Zira Joseph, Department of Radiography, Bayero University, Kano, Kano State, Nigeria. Tel: +2348130582721; E-mail: josephdlama@gmail.com

© AJMP is the official journal of the Federation of African Medical Physics Organizations (FAMPO). This is registered under Nigerian company number (CAC/IT/No 54182). See http://fampo-africa.org/
ISSN 2643-5977

Received: 2020.01.09; Accepted: 2020.09.02; Published: 2020.09.10

## Abstract

Mammography is the x-ray examination of breast tissues and it is useful in the early detection of breast diseases. The radiation dose absorbed during mammography is a risk factor since it can trigger carcinogenesis. Dose optimization in mammography is imperative due to the exposures of radiosensitive tissues. This study aimed to determine the mean glandular dose (MGD) in four selected medical radio-diagnostics Centers in Lagos State, Nigeria. The study was a prospective cross-sectional one carried out in four selected hospitals in Lagos State of Nigeria. Sixty-seven women consented for the study. The entrance surface doses were measured using pre-calibrated thermoluminescent dosimeter (TLD) chips. Patient information such as age, kVp, anode/filter combination, compressed breast thickness (CBT) were captured. The MGD was calculated using the ESD and the conversion factors published by Dance. The annealed TLD chips were placed at the upper inner quadrant of the breast before compression was applied. The CBT was then measured with a meter rule. About 10% of the TLD chips were used as control, the TLD chips were read with the TLD reader after exposure and the readings were multiplied with the conversion factors. This was done for both Cranio-caudal (CC) and mediolateral oblique (MLO) views of the breast and the MGD was computed. Analysis of variance was used to determine the relationship of MGD between the Centers studied. Statistical significance was set at $P<0.05$. The result showed an average mean glandular dose of 0.74mGy and the calculated mean glandular dose for CC and MLO views were 0.33-6.41mGy and 0.28-8.59mGy respectively. The Mean Glandular Dose value obtained in this study was lower than the reference value of the IAEA (3mGy). Moreover, the MGD also depends on other factors like breast glandularity, specific beam qualities which also contribute to dose optimization.

Keywords: Compressed breast thickness; Mean Glandular Dose; Cranio-caudal; Mediolateral Oblique Projections; Dose Optimization

## Introduction

Breast cancer is the most common cancer in women worldwide. It is also the leading cause of cancer death in less developed countries [1]. Globally, breast cancer represents one in four cancers in women since 2008. Worldwide breast cancer incidence has increased by more than 20%. Mortality has also increased by 14% [2]. In Nigeria it is the commonest cancer and the majority occurs in pre-menopausal women with the peak age in the 5th decade [3].

Mammography is a specialized medical imaging modality of the breast that uses low energy x-rays to detect cancer. Mammography does not prevent breast cancer, but it can save lives by detecting breast cancer as early as possible [2]. Mammography is considered the most effective imaging technique for the early detection and diagnosis of breast cancer [1, 2]. The goal of mammography is the detection, characterization and evaluation of findings suggestive of breast cancer and other diseases [4]. In mammography, breast compression is applied to reduce the thickness of the breast. This results in improved image quality due to tissue superimposition and reduction in the amount of scattered radiation and patient radiation dose [5].

Due to the high relative radio-sensitivity of the breast glandular tissue, many studies document the dosimetry in mammographic procedures. The MGD could be influenced by many factors which could be due to equipment and patient's body habitus; equipment factors inlude tube voltage (kVp), tube current (mAs) and half value layer (HVL). Other most important factor from the patient is the CBT [6].

Optimization of exposure parameters in digital mammography is necessary to maximize the contrast-to-noise ratio (CNR) of the image, while simultaneously minimizing patient dose [6]. Previous studies had shown that a fully digital mammography (FDM) system has optimum image quality and is capable of detecting subtle calcification clusters with low dose. A study also found that exposure factors for optimal image quality depended on the composition (glandular-to-adipose ratio) of breast tissue [6].

The International Agency for Research on breast cancer has analyzed published peer reviewed articles in the literature from which they concluded that mammography screening is still effective in reducing breast cancer mortality [7].

The estimation of the absorbed dose to the breast during x-ray-based imaging is a long- established part of quality control procedures for breast imaging systems and is also necessary for risk estimation [7]. Mean glandular dose (MGD) is the most appropriate dosimetric quantity to predict the risk of radiation-induced carcinogenesis in mammographic practice [8].

Determination of MGD for an individual woman is uncertain, as it depends not only on tissue composition, but also on tissue distribution within the breast. It has been shown that changes in the distribution of glandular tissue can result in around 60 % deviation from MGD estimated using a simple breast model [9].The purpose of this study was to assess the mean glandular doses for the two basic projections in the selected hospitals in Lagos.

## Materials and Methods

The study was a prospective cross-sectional one carried out in four selected hospitals in Lagos State of Nigeria among sixty-seven women who consented for the study. The hospitals include one public hospital, one private hospital and two private diagnostic Centers. The entrance surface doses were measured using calibrated TLD chips where patient information such as age, kVp, anode/filter combination, and CBT were captured. The MGD was calculated using the entrance surface dose and conversion factor published by Dance. The annealed TLD chips were placed at the upper inner quadrant of the breast before compression was applied. The CBT was then measured with a meter rule. About 10% of the TLD chips were used as control, the TLD chips were read with the TLD reader after exposure and the readings were multiplied with the conversion factors. This was done for both cranio-caudal (CC) and mediolateral oblique (MLO) views of the breast and the MGD was computed.

### *Machine Specification*

Mammography machines from the four hospitals include, Alpha RT (mgt 101), Hospital 1; Siemens (Mammomat 3000), Hospital 2; Allengers (venus), Hospital 3; and Alpha RT, Hospital 4.

### *Ethical Consideration*

Ethical consent was approved by the Lagos State government (General Hospital Lagos ethical committee as well as signed, informed consent from volunteers were obtained.

### *Dosimetric Measurement*

Measurements were taken with the breast positioned on the breast pad and the TLD chips placed at the upper inner quadrant then compression was applied. The value of compressed breast thickness was then taken for both the craniocaudal and medio-lateral oblique views. About 10% of the TLD chips in each Center was kept away from any form of irradiation to serve as control to record background radiation. The TLD chips after exposure were read at Center for Energy Research and Training Zaria Kaduna State, Nigeria using a TLD reader, Harshaw 4500 thermo electron made in USA with model 4500 and serial no: 0810238. The result appears as a glow curve and readings were recorded. The recorded readings were converted to mean glandular dose using the conversion factors [6].

### *Procedure*

The measurement was carried out by placing the TLD chips at the center of the breast between the nipple and the chest wall and also at the center of the side to side of the breast. These dosimeters were calibrated at Lagos State University radiation monitoring and protection services. The TLDs were read out using RE-2000 semi-automatic TLD reader, also at the institute.

The doses for the two basic projections, i.e. Medio-Lateral Oblique (MLO) and Cranio-Caudal (CC) views obtained for each patient were recorded along with the parameters. With the x-ray energy ranging from 26 to 32kV, these values were read directly from the control panel of the mammographic equipment. The entrance surface dose read from the TLD chip is used for calculating the MGD received by each patient using the formula:

$$MGD = ESD \times DgN \qquad (1)$$

where ESD is the surface dose recorded and read from the TLD and DgN is the normalized glandular dose which is interpolated from the standard. The technical factors used for the interpolation are the half value layer, keV, target filter combination, compressed breast thickness (CBT) and the breast composition [10].

***Calculating Mean Glandular Dose (MGD)***

The measurement of HVLs showed the relationship between the increase in x-ray tube voltage kVp and the HVL for molybdenum/rhodium target filter combination. An increase in kVp requires more aluminum to be used to obtain the first HVL.

The HVL values at each kVp can be used to determine the MGD. MGD is the mean dose received by the glandular tissue in the whole breast and is an approximation of the actual patient dose. Therefore, MGD is a quantity determined by standard tables with the knowledge of the entrance surface dose, HVL, target/filter combination used, CBT and composition.

The next step for calculating the MGD is by interpolating the normalized glandular dose from the standard tables based on the listed factors, i.e. the HVL, the x-ray tube voltage (kVp) and compressed breast thickness (CBT) Wu *et al*. [9].

## Results

Table 1 shows the distribution of age and mean glandular dose from the four Centers and the average mean glandular dose from the four hospitals. A total of 160 TLD chips were used 2 chips for a woman.

The average mean glandular dose was 0.74mGy. The mean glandular dose from Centres 1-4 are: 0.85±0.52, 0.85± 0.51, 0.57± 0.61, 0.50± 0.40 respectively.

Table 2 shows the value of the post hoc test analysis between and within the various Centres. The P- value was not significant between Centres 1 and 2 and between Centres 3 and 4 at p>0.05. P value for Centre 1 and 2 is 0.812 for Centres 3 and 4 is 0.719.

**Table 1.** Summary of the age and mean glandular dose from the various Centres and the mean glandular dose

| | C 1 | C2 | C3 | C4 | Mean |
|---|---|---|---|---|---|
| **AGE(yrs)** | 50.94±7.61 | 50.93±7.61 | 49±7.63 | 47±13v8.8 | 49.72±7.8 |
| **MGD (mGy)** | 0.85±0.52 | 0.84±0.52 | 0.57±0.61 | 0.50±0.40 | 0.74±0.58 |

**Table 2.** Result of the Post Hoc ANOVA of the MGD within the centers

| | MGD | P value |
|---|---|---|
| **Center 1** | Center 2 | 0.812 |
| | Center 3 | 0.197 |
| | Center 4 | 0.058 |
| **Center 3** | Center 1 | 0.197 |
| | Center 2 | 0.205 |
| | Center 4 | 0.791 |

## Discussion

The breast dose varies widely with composition and thickness as well as the choice of imaging equipment and radiographic technique [2].

The findings of this study reveals an average mean glandular dose of 0.74mGy; though the mean value is lower than the published reference dose level for mammography which is 3mGy. A wide range in doses was still noted 0.03-3.19 mGy. This can be due to different tube output, half value layer and anode/filter combination. Thus, the difference may be attributed to factors such as difference in patient`s anatomies and in x-ray units [6].

Comparing the MGD of the present study which ranged from 2.4mGy to 3.4mGy with the dose achievable from the IAEA dose guidelines which ranges from 1.0mGy to 3.6mGy (achieved for the same range of CBT as that of this study), it is evident that the dose is well below the guideline protocol [13].

Centers 1and 2 showed no significant difference in their MGD distribution likewise Centers 3 and 4. This was discovered in the post hoc ANOVA analysis. This could be due to dose reduction between digital machines and film/screen conventional machine. The range calculated MGD for CC and MLO views were 0.33-6.41mGy and 0.28-8.59mGy respectively. This is lower than the value gotten from a work done by Ogundare *et al*. (2009) in Oyo State Nigeria which ranged between 0.26-21.26mGy and 0.2-0.98mGy for MLO and CC views respectively. This could be due to difference in tube output and technical parameters. The difference observed between the MGD from the CC and MLO can be due to the pectoralis major muscle in the MLO view. This agrees with a work by Bor *at al*. (2008).

## Conclusion

The MGD value gotten, namely 0.74mGy, was lower than the published dose reference value of 3mGy by IAEA. Because of the wide variation in the dose distribution, dose optimization is still necessary in the Centers. This work was unable to separate the mean glandular doses according to the various anode/filter combinations and hence, further research on this is recommended.

## Acknowledgments

We will like to appreciate the staff and management of Center for Energy Research and Training Zaria for annealing and reading all the TLDs used in the study.

## Abbreviations

TLD: Thermoluminescent dosimeter; CBT: Compressed breast thickness; MLO: Medio-Lateral Oblique; CC: Cranio-Caudal; MGD: Mean glandular dose.

## Author Contributions

All authors contributed equally to this study and gave their final approval.

## Competing Interests

The authors have declared that no competing interest exists.

## References

[1] Jemal, A., Bray, F., Center, M. M., Ferlay, J., Ward, E., & Forman, D. (2011). Global cancer statistics. *CA: a cancer journal for clinicians*, *61*(2), 69-90.

[2] Inoue-Choi, M., Lazovich, D., Prizment, A. E., & Robien, K. (2013). Adherence to the World Cancer Research Fund/American Institute for Cancer Research recommendations for cancer prevention is associated with better health-related quality of life among elderly female cancer survivors. *Journal of clinical oncology*, *31*(14), 1758.

[3] Abdulkareem F. Epidemiology and Incidence of Common Cancers in Nigeria: Cancer Reg & Epid Workshop; 2009.

[4] Tabar, L., Yen, M. F., Vitak, B., Chen, H. H. T., Smith, R. A., & Duffy, S. W. (2003). Mammography service screening and mortality in breast cancer patients: 20-year follow-up before and after introduction of screening. *The Lancet*, *361*(9367), 1405-1410.

[5] Brenner, D. J., Sawant, S. G., Hande, M. P., Miller, R. C., Elliston, C. D., Fu, Z , Randers-Pehrson, G. & Marino, S. A. (2002). Routine screening mammography: how important is the radiation-risk side of the benefit-risk equation?. *International journal of radiation biology*, *78*(12), 1065-1067.

[6] Olarinoye, I., & Sharifat, I. (2010). A protocol for setting dose reference level for medical radiography in Nigeria: a review. *Bayero journal of pure and applied sciences*, *3*(1).

[7] Dance, D. R., Skinner, C. L., Young, K. C., Beckett, J. R., & Kotre, C. J. (2000). Additional factors for the estimation of mean glandular breast dose using the UK mammography dosimetry protocol. *Physics in medicine & biology*, *45*(11), 3225.

[8] Ogundare, F. O., Odita, A. N., Obed, R. I., & Balogun, F. A. (2009). Mean glandular doses for women undergoing mammographic breast screening in Oyo state, Nigeria. *Radiography*, *15*(4), 327-332.

[9] Bor, D., Tukel, S., Olgar, T., Toklu, T., Aydın, E., & Akyol, O. (2008). Investigation of mean glandular dose versus compressed breast thickness relationship for mammography. *Radiation protection dosimetry*, *129*(1-3), 160-164.