Session 8

Radiation protection in mammography, dental and maxillofacial imaging and other diagnostic modalities

DEVELOPMENT OF A COMPRESSED DENSE BREAST PHANTOM FOR TESTS IN MAMMOGRAPHY

A.P. MOURÃO[1,2], F.A. OLIVEIRA[1], J.M. ARVELOS[1], M.B. FLORES[2]
[1]Biomedical Engineering Center, CEFET-MG
[2]Departamento of Nuclear Engineering, UFMG
Belo Horizonte, Brazil
Email: aprata@cefetmg.br

M. CHEVALIER, M. CASTILLO
Departamento de Radiología y Medicina Física, UCM
Madrid, Spain

Abstract

Currently, in the most population-based breast cancer screening programs, digital mammography (DM) is used as the primary diagnostic imaging method. Digital Breast Tomosynthesis (DBT) reduces the effects of overlapping by offering better characterization of the mammographic findings. Alterations in breast images with a high percentage of glandular tissue are more difficult to be observed when compared to fatter breasts. In the work, a compressed dense breast phantom was developed to use in quality tests for images in mammographic and breast tomosynthesis equipments. The phantom was made of composed resins with X-ray absorption similar to the glandular tissue. This phantom has a semicircular shape with 10 x 18 cm^2, with 5 cm of thickness divided in 3 plates. Inside the phantom, it was placed six sets of microcalcifications of 100 to 600 microns, a set of spherical nodules and a set of irregular nodules. Mammography digital images using a mammographic digital radiography (DR) were generated and they allow observing some alterations. The compressed breast phantom was successful in the representation of a glandular breast with nodules and microcalcifications and it will be useful for tests in mammographic and DBT equipment's.

1. INTRODUCTION

In global statistics, breast cancer is one of the leading causes of cancer death in women [1, 2]. In 2012, more than 1.67 million new cases and more than 521,000 deaths were estimated for the world, corresponding to 14.7% of cancer deaths in women [3]. In Brazil, according to the Brazilian cancer institute INCA, more than 57 thousand new cases of breast cancer were estimated by 2016 [4].

At the same time that the incidence tends to increase, mortality in developed countries is declining mainly due to the early detection and the best conditions for the treatment of this disease [5]. Mammography is a 2D imaging technique, which can also be used for biopsy and therapy procedures, becoming one of the main tools for the early diagnosis of breast cancer [6]. The similar attenuation to the X-rays between the healthy and injured tissue together with the superposition of the tissues in the reconstructed image make it difficult to obtain the early diagnosis [7].

Indications for presence of breast cancer may be based on four types of records that appear in mammographic images: the characteristic morphology of a tumor mass, with irregular and spiculated margins; presence of calcifications; distortions of tissue normality patterns generated by the disease; asymmetry between corresponding regions of the left and right breasts [6].

Calcifications are mineral deposits of calcium within breast tissue that appear as small white regions on mammographic images [2]. There are two types of calcifications: macrocalcifications and microcalcifications [8]. Macrocalcifications are particles that are easily visible in mammographic images because of their size. These structures are frequently associated with benign fibrous nodules or degenerative changes in the breast tissues, such as the aging of the mammary arteries [4].

Microcalcifications are calcified particles with a small size. A clustering of these structures may indicate incipient cancer, its clustering shape and arrangement indicate a greater or lesser probability of a future tumor [4].

Considering that between 28% and 30% of breast cancers are associated with the tissue density considered, breast density represents an important risk factor for development of pathologies, making it necessary to develop techniques that consider the image quality in dense breasts [10].

It is thus, DBT is developed as an alternative technique that presents a lower sensitivity to digital mammography for the detection of microcalcifications and allows performing 3D mammary projections, being able to significantly decrease the superposition of tissues and reducing the need for additional incidences [2].

Breast pathology diagnosis is focused in three main types of lesions witch can be distinguished, named calcifications, masses and structural distortions [11, 12]. In a breast compressed phantom, these three lesion types were replicated in three dimensions. For that is imposed to obtain materials with a linear attenuation coefficient correspondent to the breast tissues and pathologic modifications. Different lesion structures with different sizes need to be distributed in the volume of the breast phantom. This perspective has the intention to represent minimally the modifications visualized in a real breast mammogram for the use to test the performance of the mammographic devices.

The purpose of the work was to develop a compressed breast phantom representative of a dense breast compound of three plates in PMMA and compound resins. Inside the resin plate some representative structures for spherical and irregular mass and calcification groups were inserted. This phantom was made to verify the performance of radiodiagnostic breast devices.

2. METHODS

It was made a breast compressed phantom divided in three plates and bidimensional images were produced to make a first evaluation of the pathologic structures represented inside a plate.

2.1. Phantom design

The phantom is composed by three plates with dimensions of 180 mm in width and 100 mm in length. Two plates are 20 mm thick with the circular edge curled, one plate is homogeneous made of PMMA and the other is made of a composite of acrylic resins. The third plate is 10 mm thick made of PMMA and is placed between the other two other plates making up a volume of 180x100x50 mm^3. Fig. 1 illustrates a schematic drawing with the phantom dimensions.

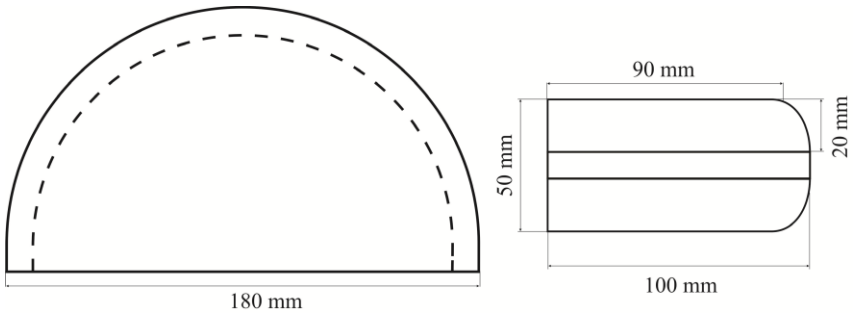

FIG. 1. Dimensions of the breast compressed phantom.

The plate made of acrylic resins exhibits absorption of the X-ray beam similar to that of the glandular tissue and represents the absorption of a glandular breast. Within its volume, it was placed some structures with higher X-ray absorption, representing pathologic lesions.

2.2. Internal structures

It was placed six calcification groupings, six spherical masses and six irregular masses with different sizes. Spherical nodules are representative elements of commonly benign cysts and changes, whereas irregular nodules are representative elements often associated with malignant changes. Grouped microcalcifications are often the earliest changes associated with malignant neoplasm of the breast. The positioning of the changes is represented in the distribution map shown in Fig. 2.

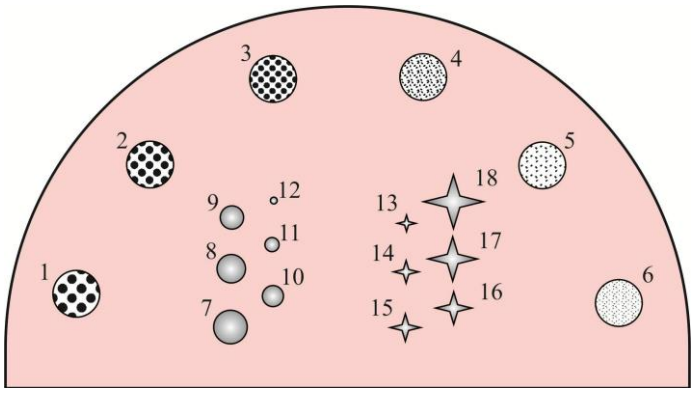

FIG. 2. Map with the changed structure distribution.

Microcalcification clusters were developed through small elements rich in calcium. Each cluster contains about 10 to 15 granules of sizes defined by a range of values. Table 1 lists the size of each microcalcification cluster.

TABLE 1. Microcalcification sizes.

Group	1	2	3	4	5	6
Size (μm)	>590	420-590	300-420	177-300	150-177	106-150

The spherical nodules are solid elements of different diameters. Table 2 lists the dimensions of the spherical nodular lesions and their positions inside the plate are shown in the Fig 2.

TABLE 2. Dimensions associated with spherical nodular lesions.

Spherical Nodule	7	8	9	10	11	12
Size (mm)	~8,5	~6,0	~4,5	~4,0	~3,0	~2,5

The nodules located at positions 13 to 18 are irregular and rigid elements of varying diameters with the positions defined in the distribution map in the Fig. 2.

2.3. Phantom assembly

The phantom volume can be assembled with 4 or 5 cm thick, with 2 or 3 plates respectively. The plate set allows irradiating the phantom with the glandular tissue plate, containing the alterations, in four different compositions, as shown in the scheme of the Fig. 3.

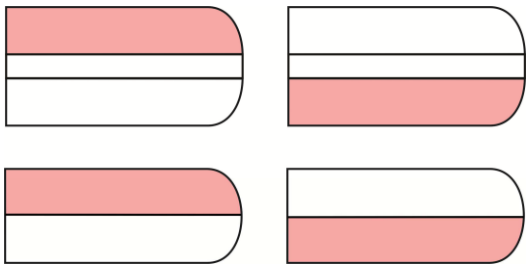

FIG. 3. Phantom assembling.

2.4. Mammographic System

Image to test the phantom was acquired in a Hologic equipment model Selenia Dimensions. The phantom exposition was assembled with 5 cm thick, and the protocol used with AEC (Automatic Control Exposition) is shown in the Table 3.The mammogram is a single projection image (2D).

TABLE 3. Acquisition protocol parameters.

Target	Filter	Voltage	Charge
tungsten	aluminium	30 kV	58.9 mA.s

3. RESULTS

Image tests were done with the breast phantom 5 cm thick and the resin plate was placed under the others for exposition in the mammographic system. Fig. 4 *a* presents an image of the plates used to compound the phantom, transparent plates are made in PMMA and the pink plate is made in resin. Fig. 4*b* presents the mammogram generated with the breast phantom, showing where the lesions structures are placed.

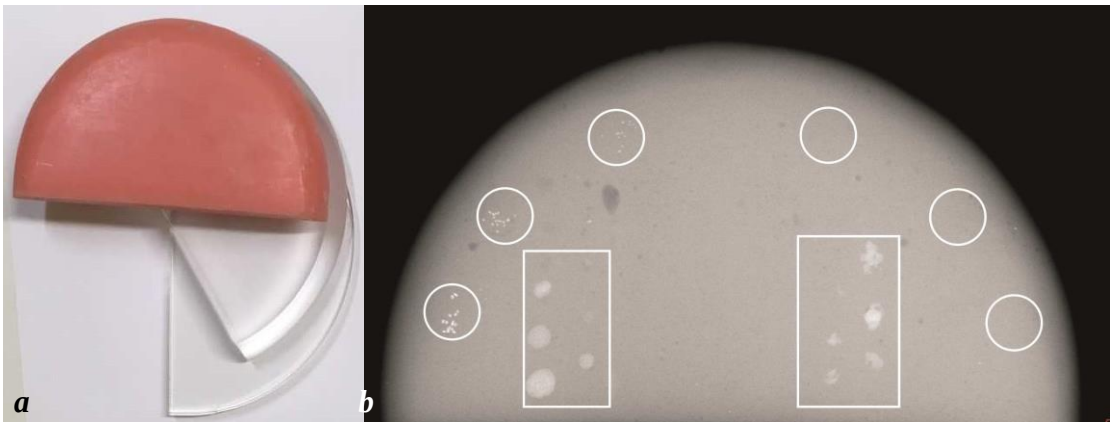

FIG. 4. Compressed dense breast phantom. Plate image (a) mammogram (b).

IFig. 5 presents in detail images of the microcalcification cluster 1 to 5 in a zoom of 300%. In the clusters 1 to 3 (>300 µm) the calcifications are easily observed.

FIG. 5. Images of microcalcification cluster 1 to 5. Scale 3:1.

Fig. 6 presents in detail images of the spherical masses 7 to 12 in *a* and irregular masses 13 to 18 in *b*, in these images don't have zoom.

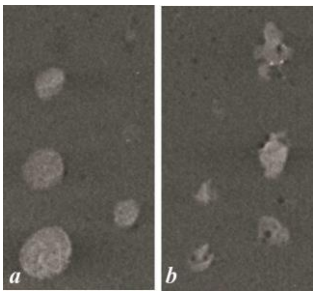

FIG. 6. Images of masses, spherical (a) and irregular (b).

4. DISCUSSIONS

In the work it was developed a compressed dense breast phantom composed by three interchangeable solid plates. Two plates were made in PMMA and the third one was made using a mixed of resins to obtain a similar absorption of the glandular tissue for the X-ray beam. Inside the resin plate it was placed structures representing some lesions in the breast.

The use of interchangeable plates allows changing the position of the lesions structures in the bottom or in the top of the phantom, and the plates association allows to have a compressed breast phantom with 4 ou 5 cm thick. With these characteristics it's possible to perform tests in different conditions.

A group of six spherical masses with different diameters and with an X-ray absorption characteristic higher than the glandular tissue was introduced in a known area. In the mammogram it was easy to recognize the four largest spherical masses. The two smallest masses may be better observed varying the image controls. The group of six irregular masses placed in a known area of the phantom was easily observed in the image test; only the smallest irregular mass was recorded as subtle structure.

The microcalcification clusters were easily recognized in the test image because they have absorption higher than the other structures inside the phantom. The clusters 1, 2 and 3 with larger calcifications (>300μm) can be observed easily. The cluster number 4 (177-300 μm) can be observed but it is not so clear. The microcalcification cluster number 5 (150-177 μm) could hardly be observed and it was not possible to observe the microcalcifications smaller than 150 μm present in the cluster 6 in the test image.

5. CONCLUSIONS

A compressed dense breast phantom with an interchangeable plate containing structures simulating microcalcification clusters, spherical and irregular masses has been introduced and applied in a digital mammographic image test. The plate association has allowed obtaining a changeable breast phantom and is possible to modify its thickness and the position of the structures placed inside the resin plate.

The structures placed inside the resin plate had a good answer in the image test, in this first test only the smallest microcalcification couldn't be observed, the other structures could be observed. So this breast phantom with the resin plate containing abnormal structures had a reasonable resemblance to mammographic lesion detection tasks.

This phantom has a potential for application to observing the image answer generated by different mammographic equipment's. Test in DBT equipment can be done for the evaluation of the phantom with the structures simulating lesions placed in different levels of the phantom by the plate position change.

ACKNOWLEDGEMENTS

The authors are thankful to FAPEMIG & CEFET-MG for their support in this study.

REFERENCES

1. OLIVEIRA, M. *et al*. Average glandular dose and phantom image quality in mammography. *Nuclear Instruments and Methods in Physics Research*, **580** 1, (2007) 574-577.
2. CASTILLO, M.; CHEVALIER, M.; CALZADO, A., Estudio de los valores de dosis a pacientes en exámenes de tomosíntesis de mama estimados con dos métodos distintos. *Revista de Física Médica* **16** 3 (2015) 35-46.
3. IARC - International Agency for Research on Cancer. *Cancer Today* (2012), www.gco.iarc.fr/today
4. MINISTÉRIO DA SAÚDE. *Instituto Nacional do Câncer* (2016), www2.inca.gov.br/wps/wcm/connect/tiposdecancer/site/home/mama
5. PARKIN, D. M.; BRAY, F. I.; DEVESA, S. S., Cancer burden in the year 2000. The global picture. *European Journal of Cancer* **37** 8 (2001) 4-66.
6. DANCE, D. R.; CHRISTOFIDES, S.; MAIDMENT, A. D. A., *Diagnostic radiology physics*: A handbook for teachers and students, IAEA, Vienna (2014).
7. SHERMIE, R. B. et al. Supplemental breast cancer screening with molecular breast imaging for women with dense breast tissue. *American Journal of Radiology* **207** (2016) 450-457.
8. GABRIEL R. P., Clasificación de masas en imágenes de mamografías utilizando redes bayesianas, Huajuapan de León (2014).
9. BANKMAN, I. N., Handbook of Medical Image Processing and Analysis, Academic Press, New York (2009).
10. BREM, R. F. et al. Assessing improvement in detection of breast cancer with three-dimensional automated breast US in women with dense breast tissue: the SomoInsight Study. Radiology **274** 3 (2014) 663-673.
11. COCKMARTIN, L. *et al*., Design and application of a structured phantom for detection performance comparison between breast tomosynthesis and digital mammography. *Phys. Med. Biol.* **62** 3 (2017) 758-780.
12. PEART O., *Mammography and Breast Imaging:* Just the Facts, McGraw-Hill, New York (2011).

Shielding Design Requirements for a Digital Breast Tomosynthesis (DBT) System on a Mobile Screening Unit

Niall Phelan

BreastCheck – The National Screening Service
Medical Physics Dept.
36 Eccles St.
Dublin 7
IRELAND

Abstract. Despite the significant improvement in image quality achieved as a result of the transition from analog to digital mammography in recent years, the problem of imaging overlying breast tissue continues to limit the sensitivity of the examination. Digital Breast Tomosynthesis (DBT) has emerged as an enhanced 3D imaging technique, using limited angle tomography, to improve imaging of overlying tissue, particularly in the dense breast. DBT differs from standard digital mammography in the x-ray spectrum used (kV, anode target and filter) and imaging geometry as multiple image projections are acquired through an angular range around the breast. DBT workload may also be increased due to the acquisition of a combination of 2D and 3D views for each examination. In anticipation of the future use of DBT techniques for breast screening, it was prudent to review the existing shielding solutions for screening clinics and mobile screening units in order to consider any remediation which may be required for existing units and to specify optimal shielding design for new mobile units. The results suggest that some changes our current shielding approach may be warranted, particularly for high workload situations.

1. Introduction

Radiation shielding requirements for existing mobile breast screening trailers used data based on scatter radiation intensity around analog mammography x-ray units principally using Mo/Mo anode/filter x-ray beams from a workload of conventional 2D mammography [1,2,3]. The worst case scenario for scatter radiation intensity was determined to be *7.6μGy@1m* which is also the figure proposed for use by the British Institute of Radiology working party on shielding for diagnostic radiology [4].

More recently, as breast screening transitioned to 2D digital mammography, a wider variety of x-ray spectra have been employed utilising Tungsten (*W*) and Rhodium (*Rh*) anode targets, and *Rh,* Silver (*Ag*) and Aluminium (*Al*) filtration, typically operating at 30-40kV$_p$. Judge et al. have measured scattered radiation intensity for a wide variety of currently available x-ray spectra found in a range of modern 2D digital mammography systems and confirmed that the maximum scatter factor used for the original design calculations overestimates the scatter for digital mammography systems [5]. This work also observed system specific differences in the distribution of scattered radiation which may impact future shielding consideration. Kunzel at al. also measured ambient scatter around a Siemens mammography system for a number of anode/filter combinations under clinical conditions and found that scatter air-kerma for *W*/*Rh* was lower than that for *Mo*/*Mo* [6].

On this basis, we have continued to conservatively use a scatter radiation intensity figure of 7.6μGy@1m per exposure when performing risk assessment for 2D digital mammography on mobile screening trailers. The inclusion of 3mm *Al* sheet bonded within the external and internal panels and doors to the x-ray room has previously been determined to provide satisfactory shielding to achieve the recommended design criterion of 0.3mGy/year. This solution has become a *de-facto* standard for mobile mammography screening trailers operating in Ireland and the UK.

In recent years, there has been significant development and increasing clinical adoption of Digital Breast Tomosynthesis (DBT) which offers 3D imaging capability for improved visualization of pathology, particularly in the dense breast. DBT uses limited angle tomography to acquire multiple image projections in order to reconstruct individual image planes through the breast. Typically images are produced using a higher energy x-ray spectrum (*W* anode; 30-40kV$_p$). Most 2D digital mammography systems installed have the capacity for future upgrade to DBT imaging. The clinical evidence base for DBT imaging in breast screening continues to build [7] and in anticipation of the potential future use of DBT techniques for breast screening, it was prudent to review the existing shielding solutions for screening clinics and mobile screening units in order to consider any remediation which may be required for existing mobile trailers and to specify optimal shielding design for new mobile trailer units.

Yang et al. (2016) have recently published comprehensive measurements of scatter radiation intensity around Hologic Dimensions (Hologic, Bedford, MA) DBT systems in clinical use for typical workloads [8] and we have used this data for our analysis. We have also made similar scatter intensity measurements locally, following up our previous measurements on 2D systems [5] which corroborate the published measurements.

2. Materials and Method

At BreastCheck, the Irish national breast screening programme, we have recently installed 15 Hologic Dimensions DBT systems as part of a phased replacement programme. DBT is currently used in our screening service only for assessment and work-up of screen detected lesions.

Workload assumptions: For risk assessment, we currently estimate a workload of 40 patients per day for 50 weeks per year (10000 patients/year). This represents a conservative estimate as detailed analysis of real screening data over a number of recent years suggests actual workload has been in the region of 5000 patients/year. Standard 4-view 2D mammography is currently performed which may be modified for DBT screening.

Mobile unit design and occupancy: the nearest external barriers on the mobile unit are the wall panels behind the patient and behind the gantry at a distance of 1.5m but in fact, there is relatively lower scatter incident on these barriers due to patient self-attenuation and attenuation by the gantry itself. The nearest lateral barrier is to the internal changing cubicle and corridor at a distance of 1.75m. Occupancy of 5% was therefore proposed for all areas outside the x-ray room. All panels to the trailer x-ray room include 3mm *Al* sheet. The trailer is supported on chassis of Steel beams with side-panels to the ground so there is no potential for occupancy under the trailer. A single 1mm thick *Al* sheet is used in the construction of the trailer roof.

Clinical X-ray spectra and air-kerma: exposure data from a patient dose survey data was used to estimate typical values of air-kerma at 1m from the tube focus (D^1_P). Compressed breast thickness could be broadly divided into two categories; average breast technique, using mean exposure factors of 30kV *W/Rh* and large breast technique using exposure factors in the range *31-35kV W/Ag*. Equivalent exposure factors for DBT image acquisition for the same patients were 30kV *W/Al* and 40kV *W/Al* respectively (Table 1).

2D	**AVG**	**LGE**	**3D DBT**	**AVG**	**LGE**
% examinations	80%	20%	% images	80%	20%
D^1_P per image (mGy)	2.5	5.3	D^1_P per image (mGy)	2.3	5.5
X-Ray spectrum	30W/Rh	35W/Ag	X-Ray spectrum used	30W/Al	40W/Al

Table 1. Distribution of exposure factors

These data were matched to the published scatter fraction data [8] for use in the calculation of scatter at relevant barriers.

Transmission Factors; transmission data for various materials and for the clinically used mammography spectra have been published [9] but there is no published data for Aluminium. The construction of the panels surrounding the trailer x-ray room also affords significant additional protection. Realistic transmission measurements through a sample of actual external panel material (60mm total thickness, containing GRP, insulation, laminated plyboard and 3mm *Al*) were performed as well as for additional and substitute materials. For the internal partition and door, no actual sample was available so 3mm *Al* only was assumed. Transmission factors calculated from the primary beam measurements using set-up geometry to simulate broad beam transmission are presented in Table 2.

Barrier Material	**Transmission Factor**			
	30W/Rh	**35W/Ag**	**30W/Al**	**40W/Al**
3mm *Al*	0.056	0.089	0.099	0.166
Ext. Panel (inc.3mm *Al*)	0.011	0.022	0.035	0.067
Ext. Panel (inc.3mm *Al*) +3mm *Al*	0.003	0.007	0.020	0.035
1mm Mild Steel	0.003	0.003	0.018	0.020
1mm Stainless Steel	0.003	0.003	0.018	0.020

Table 2. Transmission factors for various barrier materials at clinical spectra

Scatter Fractions: the 4-view standard mammography examination includes a cranio-caudal (CC) and oblique (MLO) view of each breast. For the oblique views, a standard 45^0 angle is used clinically, with opposite orientation for left and right breast image acquisition. Maximum scatter fraction laterally incident on each vertical barrier to a height of 2.1m from the floor was determined for each examination view from the published scatter data [8]. The scatter distribution for this system exhibits two strong peaks at 25^0 and 160^0 so for standard views, maximum scatter is directed towards the floor and ceiling except for one oblique view of each examination.

3. Results

Scatter radiation intensity was measured for a number of realistic and conservative workflow scenarios and the annual transmission outside a number of barrier materials determined based on the experimental data are presented in Table 3.

Conservative [unrealistic] scenario (W I): 50 patients/day; 50 weeks/year; standard 4-view mammography examination including combination 2D and DBT imaging of each patient. All patients assumed to have large compressed breast thickness.

Conservative [evidenced workflow] scenario (W II): 50 patients/day; 50 weeks/year; standard 4-view mammography examination including combination 2D and DBT imaging of each patient. Proportional compressed breast thickness determined by workflow evidence (Table 1).

Barrier @distance	**Annual Dose (mGy/year)** *[0.3mGy/year design criterion]*			
	W I	**W II**	**W III**	**W IV**
Internal Partition @1.75m 3mm*Al* only	0.53	0.34	0.31	0.29
Ext. Panel @1.5m 60mm(inc.3mm *Al*)	0.48	0.19	0.17	0.17
Ext. Panel @1.5m 60mm(inc.3mm *Al*)+3mm *Al*	0.24	0.09	0.08	0.08
Internal Partition @1.75m 1mm Steel only	0.05	0.05	0.04	0.03

Table 3. Annual transmitted dose for various workload and shielding scenarios

Realistic [evidenced workflow] scenario (W III): 50 patients/day; 50 weeks/year; standard 4-view mammography examination including two CC 2D images and two combination 2D plus MLO DBT images of each patient. Proportional compressed breast thickness determined by workflow evidence
Realistic [evidenced workflow] scenario (W IV): 50 patients/day; 50 weeks/year; standard 4-view DBT mammography. Proportional compressed breast thickness determined by workflow evidence

4. Discussion

The results demonstrate that the external trailer panels which include 3mm *Al* will continue to offer satisfactory protection in all cases except for the unrealistically conservative workflow situation. Mobile units are typically sited at least 2m distance from any adjacent building to enable access to services and assuming 100% occupancy in an adjacent building, the design criteria may be exceeded, although this is without consideration of the building construction and the nature of mobile screening where permanent occupancy would be unusual. In this situation, a shorter location period of six months (50% occupancy) would achieve the design criteria.
For the internal partition and door to the x-ray room, 3mm *Al* is close to the design criteria of 0.3mGy/year for the realistic workflow situations although this partition does contain additional material which has not been measured. It may also be prudent to consider the possibility of a permanent receptionist working on the screening unit at the reception desk 6m from the x-ray machine. Assuming 100% occupancy, the design criteria of 0.3mGy/year would be exceeded at this location, although this is without consideration of other internal barriers.

5. Conclusion

For mobile breast screening using DBT, it would be prudent to consider the use of 1mm Steel shielding in the internal partition and door to the x-ray room.
Continued use of 3mm *Al* shielding bonded to the external body panels continues to be justified.
Existing floor construction over a Steel chassis remains satisfactory but consideration may need to be given to additional shielding in the ceiling for siting adjacent to a high occupancy building.

6. References

[1] SIMPKIN, Douglas J, Scatter radiation intensities around mammographic units, Health Physics 70,2 (1996) 238-244
[2] SIMPKIN, Douglas J, DIXON, Robert L, Secondary shielding barriers for diagnostic x-ray facilities: scatter and leakage revisited, Health Physics 74,3 (1998) 350-365
[3] SIMPKIN, Douglas J, Transmission data for shielding diagnostic x-ray facilities, Health Physics 68,5 (1995) 704-709
[4] SUTTON, DG et al., Radiation shielding for diagnostic x-rays 2nd Ed., BIR Report (2012)
[5] JUDGE et al., Scatter Radiation Intensities around Full Field Digital Mammography Units. Br J Radiol (2013) 86:20120130
[6] KUNZEL R et al., Ambient dose equivalent and effective dose from scattered x-ray spectra in mammography for Mo/Mo, Mo/Rh and W/Rh anode/filter combinations. Phys Med Biol 51,8 (2006) 2077-2091
[7] HODGSON R et al., Systematic review of 3D mammography for breast cancer screening. The Breast 27 (2016) 52-61
[8] YANG K et al., Scatter radiation intensities around a clinical digital breast tomosynthesis unit and the impact on radiation shielding considerations, Med Phys 43,3 (2016) 1096-1110
[9] Xinhua L et al., Transmission of broad W/Rh and W/Al (target/filter) x-ray beams operated at 25-49kV_p through common shielding materials, Med Phys 39,7 (2013) 4132-4138

Pathological Behaviour of Bilateral, Multifocal and Multicentric Synchronous Egyptian Breast Cancer as detected by preoperative ultrasound and its relation to breast density

Abstract
Current national screening programs totally depend on mammographic evaluation. After increased incidence of breast cancer in women under the age of 35, mammography sensitivity is now being in question. several factors added to decrease sensitivity of mammography, as increase density in older age groups and increase the aggressiveness of tumour biology. All these factors will change the reliability of the national screening program. Patients and method 138 patients diagnosed with cancer breast underwent both mammography and sonography to determine percentage of patient with more than one focus, age and density distribution breast cancer in the affected patient and accuracy of both mammography and US By studying this population, we found that around 61,44% have areas of density ranging from dense breast, heterogenous density or scattered density. These areas of density render the mammography a less sensitive tool as its sensitivity fall to 34.09%, while that of US was 77.27%. Conclusions as cancer breast became prevalent in younger population and as this population is relatively insensitive to mammography we recommended the use of Automated Breast US (ABUS) in the national screening program. Key words; breast cancer, screening program, automated breast ultrasound, more than one focus.

Introduction

Early and accurate diagnosis of the extent of disease has a deep impact on the extent of surgical approach, surgical resection and hence disease-free interval. Breast cancer is the most common of all cancers affecting women below 40. Mammography is the first step in management of any breast mass, and up till now it is the only imaging modality used in national screening programs. One of the diagnostic challenge facing mammography is dense breast tissue. Dense breast tissue obscures tumors on mammograms, making it more difficult to interpret. This is reflected as increased missed lesions with subsequent increase in healthcare expenses and patient anxiety. It is clearly shown that breast cancer deaths for multifocal and/or diffuse tumors versus unifocal type was 1.96. The bad prognosis in this aggressive tumor biology seen in younger age group is aggravated by late presentation. All these changes necessate the presence of strong screening program that can deal with the changes in tumor biology and the younger age of prevalence.The aim of **this** work is to study the distribution of density in breast cancer patients, compare the aggressiveness of more than one focus disease with that of one focus. Also to determine the efficacy of US in evaluating this disease entity and whether it can be used for management.

Material and method

This is a retrospective study included all breast cancer patients in our data base from 6/2015 to 6/2016. All patients in our study were subjected to history

taking for relevant data, clinical examination in surgery department, both mammography and ultrasound examination in radiology department with biopsy taking under guidance of US if needed. Mammography was done using (Selenia, Hologic 2D Digital Mammography). Ultrasound examination was done, using a real time, dynamic equipment (GE Voluson 730 pro, GE Healthcare, USA),. Patients are divided according to the ACR (American College of Radiology) classification; grade 1 is fatty breast, grade 2 is scattered fibro glandular tissue, grade 3 heterogeneous density. (Grade 2 and 3 are combined in one group in this study) and grade 4 is dense breast.

Results

138 patients previously diagnosed as having cancer breast were included in the study, of whom 44(31.88%) have more than one focus of breast cancer and 94 patients (68.12%) have only one disease focus. The mean age of patients with more than one focus is 44.6±8.2 while the mean age of patients with only one focus of breast cancer is 47±11.8. Also, the mean age differs between patients when classified according to their breast density; patients with dense breast have a mean age of 40.5 years which is significantly less than that of patients with heterogonous and fatty breast. Fig 1 shows the percentages of each type of breast density in patients with unifocal lesion and those with more than one focus. Of the 44 patients, 14 have bilateral lesions, 26 have multifocal and 30 patients have multicentric lesions as shown in . Lymph node infiltration was found in half of the patients with more than one focus while only 26% of patients with unifocal lesion have lymph node infiltration; a difference which is statistically significant $x^2(1) = 7.37$ and P value of .007. +

The accuracy of US was 77.27% while that of mammography was 34.09%. An exact McNemar's test determined that the difference in accuracy between the US and mammography was highly statistically significant, P value of .0005. The highest accuracy of US was in the fatty group (82%).

Of the 44 patients, 14 have bilateral lesions, 26 have multifocal and 30 patients have multicentric lesions. Lymph node infiltration was found in half of the patients with more than one focus while only 26% of patients with unifocal lesion have lymph node infiltration; a difference which is statistically significant $x^2(1) = 7.37$ and P value of .007.

Discussion

There is increased risk of developing breast cancer in dense breast. Moreover, breast cancer is more likely to be missed in areas with increased density. Researches were conducted to know what causes some women's breasts to be denser than others, many factors may attribute to increased breast density; genetic is one of them, this may explain the increased incidence of breast cancer in some nations, also the increased dependence on hormone replacement therapy and contraceptive pills through increasing level of estrogen may be another important factor. Some studies have shown that women who are more physically active have a lower absolute

mammographic density compared with less active women, through decrease in body fat which is a major source of estrogen. In recent years with increased sedentary life style that resulted in increased body mass index in many populations, together with the increased usage of exogenous estrogen medication may explain the increase in breast density and hence the incidence of breast cancer. In our countries, all factors that increase breast density are prevalent, resulted in increased incidence of cancer breast in younger population. In this study, the mean age of studied population was 47 ±11.8 years while the mean age of patients with more than one focus of breast cancer is 44.6± 8.2 years. This means that breast cancer, not only became prevalent in younger population, but also increased in aggressiveness. In this study, around 61.4 % (total patients with dense and heterogeneous density breast) of the affected patients with more than one focus show areas of density that may hinder diagnosis of breast cancer by mammography . This means that the use of US is a very crucial part of any breast examination. In general, there is an inverse relationship between patient age and mammographic breast density. This study shows that the mean age of patients with fatty breast is 50.2 years while those with heterogeneous density is 51.8 years and patients with dense breast have a mean age of 40.5 years. In a study by Pisano et al, done on a sample from the general population, women with breast densities in the scattered and heterogeneously dense categories were 43% and 39%, respectively, whereas 10% have fatty breast. In this study, the prevalence of fatty breast reached 38.6%, heterogeneous-density 38.6% and dense breast 22.7 %, taking in consideration that our study contains women having cancer breast. This means that over 60% of these patients show areas of density that may render mammography a less sensitive tool for early detection, accurate diagnosis and hence proper management.

Bilateral breast tumor is the affection of both breasts, whereas MF and MC were defined as more than one lesion in the same quadrant or in separate quadrants, respectively[15] on the same side. As advances in preoperative imaging continue, the number of bilateral, MF and MC tumors identified increase[16] and the incidence of bilateral breast cancer is 4–20% , and the incidence of MF MC tumors in the literature ranges from 6% to 60% . Our study showed that breast cancer with more than one focus including B, MF and MC reaches 31.88% of the total cancers detected.

The sensitivity of the mammography has been questioned a lot, and shows great difference from study to another, as Chae et al shows a sensitivity of 54.55%, in the study of Zhao et al it reaches 88.5% Also, the sensitivity varies according to the composition of the breast; extremely dense breasts show significantly lower sensitivity of screening mammography in women than in those with almost entirely fatty breasts (62.2% vs. 88.2%, respectively). In this study and for each patient the US and mammography were considered correct if the number of foci they diagnose was confirmed by the pathological examination, otherwise, the diagnosis was considered incorrect. Accordingly, the sensitivity of mammography was 34.09%, while sonography

has a sensitivity of 77.27%, it is also noted that sensitivity will change according to the composition of the breast, the difference in sensitivity of mammography and US respectively in various densities. Also, also the overall sensitivity of the mammography and US regarding unifocal and more than one focus disease. These numbers should not be compared to the screened general population but it can give a clue about the lower sensitivity of mammography in the breast cancer with more than one focus especially with increased density of the breast. Also, it seems that the accuracy will vary according to the size and numbers of the foci. All the former results, with increased percentage of dense breast and hence breast cancer especially that contain more than one focus with its bad prognostic outcome, all these factors necessitate a strong screening program that assures a prompt diagnosis as early as possible with subsequent better prognosis.

In conclusion, Since this aggressive disease entity is prevalent in young age with dense breast, and breast density is increasing due to many factors, we recommend the use of US in the national screening programs for early detection and hence better prognosis with longer disease-free interval.

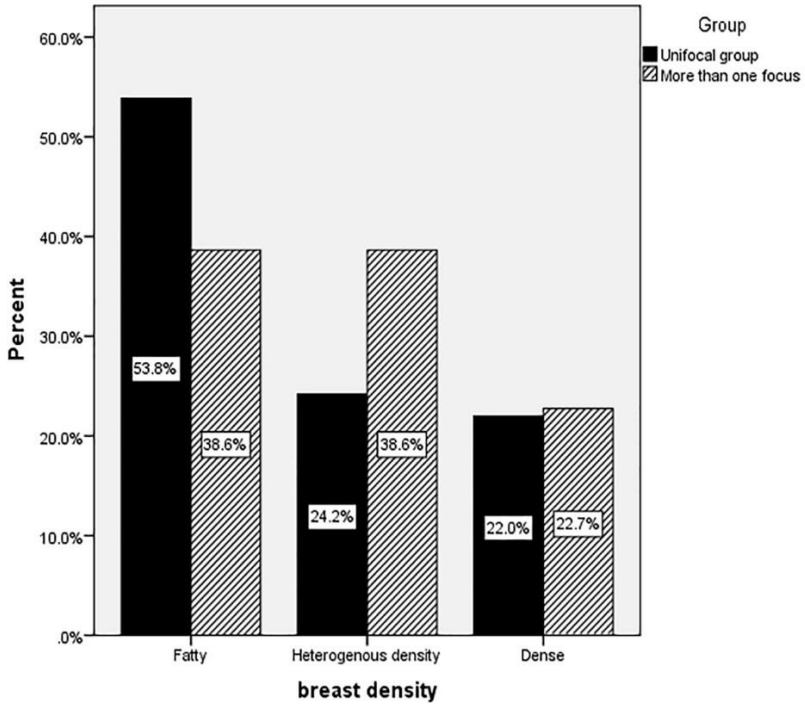

Fig 1 percentage pf each type of brest density in each group

IAEA-CN-255

ANALYSIS OF THE DECREASE IN THE PERFORMING OF COMPLEMENTARY STUDIES WITH THE USE OF TOMOSYNTHESIS IN MAMMOGRAPHY

P.M. Siles
Centro de Atención en Salud de Puriscal
Puriscal, San José, Costa Rica
pri.siles@gmail.com

Abstract

The paper consisted in the analysis of the use of tomosynthesis as a complement to 2D mammography and its repercussion on the need to resort to complementary studies to obtain the definitive diagnosis, in this case the use of ultrasound and the compression or magnification cones. Key words: mammography, tomosynthesis, ultrasound, compression or magnification cone, sensitivity

1. INTRODUCTION

Tomosynthesis is a complementary technique of the digital mammography for producing slice images (3D image). In this case a tube of X-rays is used, which moves continuously in an arc that varies in degrees and number of slides, (can change in the range of 15º, 25º and 40º), making multiple shots of low doses of radiation, which are absorbed by the breast and subsequently are reconstructed with algorithms similar to those used in tomography in slides of 1 mm.

The advantages of this technique are: better tumor definition, better evaluation of asymmetries and distortions of architecture, increased sensitivity of mammography up to 40%, especially in dense tissue.

2. MATERIALS AND METHODS

An analysis was performed during the period 2015-2016, within the radiology service of the Puriscal Clinic of the public health system of Costa Rica (CCSS).

A total of 878 mammograms were analyzed, without the use of tomosynthesis made in 2015, and 2016 mammograms with tomosynthesis performed in 2016. Of which the BIRADS diagnosis obtained was reviewed, and the percentage of use of complementary studies (ultrasound and compression or magnification cone).

3. RESULTS

The percentage obtained in 2015 of mammograms that required the use of complementary ultrasound was 25,80%, while the percentage for compression or magnification cone realized was 4,1% of the total mammographys performed without tomosynthesis.

In the case of mammograms performed with tomosynthesis in 2016, the percentage that needed complimentary ultrasound was 20,13% and the ones that needed compression or magnification cone was only 0,29% of the total of mammographys performed with the use of tomosynthesis.

4. CONCLUSION

The use of tomosynthesis decreased by approximately 5% the cases that needed complementary ultrasound, especially in dense breasts, but tomosynthesis does not replace ultrasound in the case of nodules that need to be characterized, tomosynthesis works as a complement to conventional mammography helping define lesions and determine clinical behavior.

However, in the case of complementary compression/magnification cone, the percentage decreased lower than 1%, since in tomosynthesis a volumetric image is obtained instead of a single cut, asymmetries and architectural distortions are defined better, increasing the sensitivity of mammography and making compressive cones unnecessary in most cases.

MAMMOGRAPHY DOSE AUDIT IN GHANA: *Results of a phantom studies*

Edem Sosu
Ghana Atomic Energy Commission
Accra, Ghana
edemsosu1@gmail.com

Department of Physics, University of Cape Coast
Cape Coast, Ghana
Email: edemsosu1@gmail.com

Mary Boadu
Ghana Atomic Energy Commission
Accra, Ghana

Samuel Yeboah Mensah
Department of Physics, University of Cape Coast
Cape Coast, Ghana

Abstract

Mammography Dose Audit has been undertaken on twelve mammography systems with the aim of optimizing of procedures, patient radiation protection and establishing a quality control (QC) baseline data in Ghana. Quality control assessment and mean glandular dose (MGD) estimation was performed using internationally accepted protocols. QC test performed include units assembly evaluation, radiological equipment performance test (kVp Accuracy and Repeatability, Output repeatability and Linearity, Half value layer), Short Term Automatic Exposure Control (AEC) test. Results from the MGD test shows that doses being received are within the acceptable levels with the exception of two system. For one system, MGD values exceeded the limit by 17.07% and 3.92% for the 60 mm and 75 mm equivalent breast thicknesses respectively. For the second system, the MGD exceeded the limit by 9.52% for the 75 mm equivalent breast thickness. For the Full Field Digital Mammography (FFDM) systems, the percentage difference between the calculated and console displayed MGD was within the acceptable difference level of 50%. Results of the American College of Radiology Mammography Accreditation Phantom (ACR MAP) test on the FFDM systems were below the acceptable level of 3 mGy. Results from QC test and Dose audit performed can be used as baseline data for further studies.

1. INTRODUCTION

Mammography is a specialised medical imaging tool or modality for diagnosis of breast disease and early detection of breast cancer. Mammography is a non – invasive procedure and improves a physician's ability to detect small tumours which hitherto were undetected by hand palpitation of the breast. However the quality of the image and the general performance of the mammography system depends on the level of function of the various components in the imaging process [1].

Quality control and quality assurance programme specific to mammography is deemed as a very important factor to obtain the maximum diagnostic information whiles reducing the dose delivered to the glandular tissue of the breast.

In Ghana, there is no existing routine (i.e. daily, weekly, monthly, quarterly or yearly) quality control programme in place in the country. Operators use inspection report of facilities (carried out before certificates are renewed) as evidence of quality. The purpose of this work was to undertake a quality control assessment (which included units assembly evaluation, radiological equipment performance test (tube voltage accuracy and repeatability, output repeatability and linearity, Half value layer) and Short Term Automatic Exposure Control (AEC) test assessment of twelve mammography systems in Ghana and to determine the mean glandular dose (MGD) and compare obtained values with international guidelines.

2. METHODS

2.1. Materials

The materials that were used for the research include mammography equipment, semi-circle polymethylmethacrylate (PMMA) plates, Piranha quality control kit, American College of Radiology

mammography accreditation phantom (ACR MAP), towel, bathroom scale, meter rule, lawn tennis ball and Styrofoam and Ocean 2014 software. A total of twelve (12) mammography systems, three (3) in public/government hospitals, two (2) in private hospitals and seven (7) in private diagnostic imaging centres, were chosen for the study. The three (3) in the public hospital were full-field digital mammography (FFDM) systems whiles the remaining nine (9) were computed radiology (CR) systems.

2.2. Method

The test involved unit assembly evaluation, radiological equipment performance test (kVp accuracy and repeatability, output repeatability and linearity, half value layer), short term automatic exposure control (AEC) evaluation and determination of mean glandular dose. Test were conducted according to the International Atomic Energy Agency, Human Health Series 2 and 17 [1, 2] and the European guidelines for quality assurance in breast cancer screening and diagnosis [3]

3. RESULTS AND DISCUSSION

The results from the mammography units assembly evaluation shows that the compression paddle of two out of the twelve systems was not functioning appropriately. Digital Imaging and Communication in Medicine (DICOM) header package was not installed on five systems. Results for tube voltage accuracy and repeatability, output linearity and repeatability and half value layer measurement indicated satisfactory radiological performance of all the systems. One system failed the short term automatic exposure control test whiles the test could not be performed on two systems due to malfunction of the AEC system. Results from the MGD test (table 1) shows that doses being received are within the acceptable levels with the exception of two system. For one system, MGD values exceeded the limit by 17.07% and 3.92% for the 60 mm and 75 mm equivalent breast thicknesses respectively. For the second system, the MGD exceeded the limit by 9.52% for the 75 mm equivalent breast thickness. For the Full Field Digital Mammography (FFDM) systems, the percentage difference between the calculated and console displayed MGD was within the acceptable difference level of 50%. Results of the American College of Radiology Mammography Accreditation Phantom (ACR MAP) test on the FFDM systems of 0.98 mGy, 1.35 mGy and 1.84 mGy were all below the acceptable level of 3 mGy.

TABLE 1. RESULTS OF MEAN GLANDULAR DOSE ASSESSMENT

PHANTOM THICKNESS / EQUIVALENT BREAST THICKNESS (mm)	ACCEPTABLE LEVEL (mGy)	RESULTS (mGy)											
		A	B	C	D	E	F	G	H	I	J	K	L
20/21	1.00	0.26	0.56	0.22	0.35	0.67	0.40	0.78	0.87	0.65	0.72	0.32	0.88
30/32	1.50	0.94	0.60	1.14	0.89	1.08	0.70	1.16	1.39	1.00	1.48	1.02	1.49
40/45	2.00	1.45	0.74	1.82	1.34	1.37	0.84	1.35	1.29	1.08	2.06	1.34	1.50
45/53	2.50	1.79	1.07	2.29	1.72	1.55	0.87	1.61	1.50	1.38	1.57	1.41	1.45
50/60	3.00	3.56	1.43	2.86	2.62	1.73	1.26	1.98	1.88	1.76	1.52	1.48	1.42
60/75	4.50	4.68	1.92	4.15	3.58	2.12	1.42	2.29	3.04	1.98	3.14	1.63	2.09

70/90	6.50	6.49	2.64	5.14	4.76	2.86	2.01	3.70	4.96	2.93	4.39	2.24	2.35

4. CONCLUSIONS

Results from Quality Control test and Dose audit performed can be used as baseline data for further studies. It is recommended that for systems that failed the AEC test, they AEC must be repaired before further use of the system. Mechanical problems should be corrected at the Centres to aid proper diagnosis of breast diseases.

ACKNOWLEDGEMENTS

The authors will like to acknowledge the International Atomic Energy Agency for their support in purchasing the quality control kit used to undertake the study. Many thanks to heads and staff of participating radiology departments for their commitment towards the work.

REFERENCES

[1] F. Zaoui, K. Talsmat, K. Lalaoui, Mammography Quality Assurance in Morocco. Radiological Protection of patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy. Vienna, Austria. March 2001. Pages 193 – 197

[2] International Atomic Energy Agency. Quality Assurance Program For Screen Film Mammography. IAEA Human Health Series No. 2. 2009. IAEA Vienna, Austria

[3] International Atomic Energy Agency. Quality Assurance Program for Digital Mammography. IAEA Human Health Series No. 17. 2011. IAEA Vienna, Austria

[4] European guidelines for quality assurance in breast cancer screening and diagnosis (fourth edn.) European Commission, Luxembourg, Office for Official Publications of the European Communities. 2006

Towards establishing Diagnostic reference levels in mammography practice: *Preliminary results based on phantom studies in Ghana*

Edem Sosu
Ghana Atomic Energy Commission
Accra, Ghana
edemsosu1@gmail.com

Department of Physics, University of Cape Coast
Cape Coast, Ghana
Email: edemsosu1@gmail.com

Mary Boadu
Ghana Atomic Energy Commission
Accra, Ghana

Samuel Yeboah Mensah
Department of Physics, University of Cape Coast
Cape Coast, Ghana

Abstract

Diagnostic reference level (DRL) is a dose level used in medical imaging to indicate whether the dose to a patient in a specified procedure is unusually high or low. In this work, mean glandular dose (MGD) measurements from thirteen (A – M) centres were used to calculate DRLs for a typical mammography examination in Ghana. The 95th percentile of the MGD based on polymethylmethacrylate (PMMA) phantom measurements was calculated for different breast thicknesses (20 mm – 70 mm). DRL was established as 0.90 mGy, 1.48 mGy, 1.92 mGy, 1.99 mGy, 3.14 mGy, 4.79 mGy and 5.68 mGy for 20 mm, 30 mm, 40 mm, 45 mm, 50 mm, 60 mm and 70 mm respectively. MGD values for system A (50 mm and 70 mm) exceeded the DRL by 12.54% and 13.31% respectively, system J (30 mm, 40 mm and 60 mm) by 0.40%, 7.27% and 3.33% respectively, system M (20 mm) by 3.33% and system C (45 mm) by 14.02%. Results indicates that the percentage difference between the DRL and the values that exceeded them where less than 15%.

1. INTRODUCTION

Diagnostic reference level (DRL) is a dose level used in medical imaging to indicate whether the dose to a patient in a specified procedure is unusually high or low. These levels are not to be exceeded for standard procedures when good and normal practice regarding diagnostic and technical performance is adhered to. DRL is a practical tool to promote optimization of procedure in Mammography practice.

The establishment and use of diagnostic reference levels (DRLs) have been recommended by the International Commission on Radiological Protection (ICRP) [1]. The objective of a diagnostic reference level is to help avoid radiation dose to the patient that does not contribute to the clinical purpose of a medical imaging task. In mammography, several others have proposed that the mean x – ray dose to the glandular tissue (MGD) is the best dosimetric quantity to predict the risk of carcinogenesis [2]. Even though using patient data is the ideal method for establishing DRLs, measurements on phantoms may provide a good estimate of the mean patient dose. The purpose of this study was to verify whether dose estimates from phantom measurements were a good alternative for patient data and use those that phantom data as baseline data to build upon to establish DRLs based on patient data.

2. METHODS

The study was conducted on a voluntary basis which involved thirteen mammography centres within Ghana. The output of the x – ray tube, the half value layer (HVL), the distance between focus and detector and the transmission for the compression plate for each of the systems used was determined. The tube output, the tube voltage and the HVL were measured using Piranha quality control kit connected to a laptop via Ocean 2014 software. Different thicknesses of semi-circle polymethylmethacrylate (PMMA) plates of 20 mm, 30 mm, 40 mm, 45 mm, 50 mm, 60 mm and 70 mm where simulated to represent different thicknesses of breast. Based on the applied voltage, mAs and the compressed breast thickness, the entrance air kerma at the surface of the

phantom was estimated for using the Inverse Square Law. The mean glandular dose was then calculated using equation 1.

$$MGD = Kgcs \quad (1)$$

where K is the entrance air kerma, g corresponds to a glandularity of 50% and is derived from the values calculated by Dance et al for a range of HVL [3]. The c factor corrects for difference in breast composition from 50%glandularity. The measurements were carried out according to the International Atomic Energy Agency, Human Health Series 2 and 17 [4, 5]. It was carried out on all thirteen (13) mammography systems (A – M), four (4) in public/government hospitals, two (2) in private hospitals and seven (7) in private diagnostic imaging centres. The four (4) in the public hospital were full-field digital mammography (FFDM) systems whiles the remaining nine (9) were computed radiology (CR) systems.

3. RESULTS AND DISCUSSION

The diagnostic reference levels (DRL) were determined for a range of PMMA thicknesses from 20 mm – 70 mm. The measured MGD was ordered from the lowest to the highest for a particular PMMA thickness from all the centres. The 95th percentile of the mean glandular dose based on PMMA phantom measurements was calculated for the different equivalent breast thicknesses. The 95th percentile of the calculated mean glandular dose values refers to the point at which 5% of a calculated value exceeded the referenced value. The reason this statistic is so useful in measuring data throughput is that is gives a very accurate picture of the distribution of the values. The percentage difference between the phantom based DRL and the values from the individual centres that exceeded them was also calculated and the results presented in Table 1. MGD values for system A (50 mm and 70 mm exceeded the DRL by 12.54% and 13.31% respectively), system J (30 mm, 40 mm and 60 mm exceeded the DRL by 0.40%, 7.27% and 3.33% respectively), system M (20 mm exceeded the DRL by 3.31%) and system C (45 mm exceeded the DRL by 14.02%).

TABLE 1. RESULTS OF 95TH PERCENTILE CALCULATIONS

PMMA thickness (mm)	**95th Percentile of MGD (mGy)**	**Percentage difference (%)**
20	0.90	2.64
30	1.48	0.40
40	1.92	7.27
45	1.99	14.02
50	3.14	12.54
60	4.79	3.33
70	5.68	13.31

Results from Table 1 indicates that the percentage difference between the DRL and the values that exceeded them where less than 15%.

4. CONCLUSIONS

For Quality Control purposes, the phantom approach for determining DRLs is applicable. Results shows that the percentage difference between the DRL and the values that exceeded them where less than 15%. This figure can be used as a baseline data for further studies.

ACKNOWLEDGEMENTS

The authors will like to acknowledge the International Atomic Energy Agency for their support in purchasing the quality control kit used to undertake the study. Many thanks to heads and staff of participating radiology departments for their commitment towards the work.

REFERENCES

[1] International Commission on Radiological Protection (ICRP) (1996). Radiological protection in 26 medicine. ICRP Publication 73. Ann. ICRP 26 (2).

[2] Klein R, Aichinger H, Dierker J, Jansen JT, Joite – Barfuss S, Säbel M, Schulz – Wendtland R, Zoetelief J. Determination of average glandular dose with modern mammography units for two large groups of patients. Phy Med. Biol. 42, 651 – 671 (1997)

[3] Dance, D. R., Monte Carlo calculation of conversion factors for the estimation of mean glandular breast dose. Physics in Medicine and Biology. 1990 Number 35, Pages 1211 – 1219

[4] International Atomic Energy Agency. Quality Assurance Program For Screen Film Mammography. IAEA Human Health Series No. 2. 2009. IAEA Vienna, Austria

[5] International Atomic Energy Agency. Quality Assurance Program for Digital Mammography. IAEA Human Health Series No. 17. 2011. IAEA Vienna, Austria

EVALUATION OF FUNCTIONING OF MAMMOGRAPHY EQUIPMENT

Yegros, Cesar[1] Núnez, José .Villegas, Carolina[1] Recalde, Lúciano[1]

[1]Universidad Nacional del Asunción -Facultad Politécnica

Abstract

According to WHO every year are 1.38 million new cases and 458,000 deaths from breast cancer. Is the most common deaths in women, most (269,000) occur in low- and middle-income countries where they are diagnosed in advanced stages due to lack of early detection and barriers to access to health services; What causes unnecessary suffering and an early death. Breast cancer is curable and detects early. In Paraguay, cancer is the second leading cause of death in women.

One of the main success factors of mammography studies is to have the highest possible quality of operating equipment combined with a low patient dose rate. To ensure, it is necessary to establish programs of performance verification and quality control of Mammograms

This project will evaluate the operability and quality of mammograms through measurements of physical parameters of radiation generators, imaging devices and irradiation facilities at the time of their commissioning. The appropriate physical and clinical factors used for the diagnosis of patients are also checked; using reference hospitals for the studies.

These evaluations seek to detect system failures and correct them in time. Avoiding an excessive expenditure of resources and avoiding the exit of operation.

Keywords: Mammography, Quality control, Breast cancer

Introduction

Mammography is an x-ray test that helps identify malignant changes in the chest. It's used as a diagnostic test to examine symptomatic women and also as a screening test in asymptomatic women for early detection of breast cancer, before breast lumps are perceived, ensuring the high quality of mammography and minimizing the exposure of the patients to the radiation

The success of mammography screening depends not only on technology but also on the organization of population-based programs that achieve high screening coverage in women at risk age and are accompanied by correct diagnosis and treatment for women with abnormal results.

Not any anatomical region requires such a highly specialized radiographic technique as the breast. Their tissues (glandular, conjunctive, epithelial, fatty, etc.) show very little difference in photoelectric absorption to the radiation beam; And the rest of the mammary structures, like blood vessels or ducts galactóforos, are very small. Both circumstances require extreme quality control of all components of the mammography equipment, especially the X-ray tube.

A quality assurance program should have an impact on each of the phases of the diagnostic radiology process: requesting the examinations, performing the same, interpreting the information obtained and transmitting it to the prescribing physician.

It should be noted that the benefits of quality controls can be unsuccessful if quality assurance programs do not include actions in areas such as radiation protection training and quality assurance of specialists and technicians, studies on replacement needs or acquisition of equipment and compliance with the manufacturer's recommended maintenance, evaluation of parameters that have the greatest impact on costs, etc.

The Organization for International Standardization defines assurance or quality assurance as the set of "all planned and systematic actions necessary to inspire sufficient confidence that a structure, system or component will function to its satisfaction when in service." Applying this definition to diagnostic imaging, the World Health Organization (WHO) (WHO, 1984) adds that "Function to the satisfaction in service implies the optimum quality can be obtained throughout the diagnostic process, ie, to occur at all times adequate diagnostic information with minimum exposure of patients and staff".

Within a quality assurance program, "quality control applied to radiodiagnosis comprises the measurement, evaluation and maintenance of optimal levels of all characteristics that can be defined, measured and controlled" (WHO, 1984).

In all hospitals, a Quality Control and Quality Assurance Program must be implemented in the imaging services through the radiation protection officers and inform the director of the institution of any relevant data obtained through this program.

In order to implement these programs, this project will evaluate the operation and quality of the Mammograms through measurements of the physical parameters of the radiation generators, the imaging devices and the irradiation facilities at the moment of their commissioning, and periodically thereafter. This will also verify the appropriate physical and clinical factors used for the diagnosis or treatment of patients. All this supported by written records of significant procedures and their results.

Methods

This project seeks to evaluate the correct functioning of the Mammographs, to ensure an effective clinical diagnosis, for its acquired the materials required for quality control and evaluation of mammography

The methodology of the project is based on the experimental study, through the development, verifications and tests.

The project focuses on evaluating the operation of Mammographs, through measurements, functional tests and protocols; in order to ensure the proper functioning of the aforementioned equipment; as well as being able to perform the detection and diagnosis of the equipment's drawbacks.

To this end, a quality assurance program is organized based on the daily, weekly and monthly checks by radiodiagnostic personnel, while the less frequent controls are carried out by a qualified expert in radiodiagnostic physics, who can also do The advice and evaluation of all the results of the tests made since the previous visit.

In this way, quality controls and calibration measurements will also be carried out, through phantoms, in order to guarantee the reliability of the equipment.

Results and Discussion

In the scientific area it’s proposed to collect results referring to the current state of the technology applied to imaging, specifically to the Mammography area.

Socially it is a project that supports the diagnostic quality of breast cancer for people of different social strata

In the contemporary context, the public health services are currently deprived of equipment to carry out such checks and checks, which will greatly benefit the prevention and treatment of oncological pathologies.

It is currently under development in reference hospitals at the capital level, with the first results will seek to expand the project at Departmental level and then at the national level.

Conclusions

It’s possible to evaluate the correct functioning of the mammography, if the necessary materials are acquired for the control and evaluation of the biomedical equipment, and the training to the professionals on this quality control. With this you can obtain the current status of each hospital team, so as to present a report on the situation of

each team and possible solutions in order to avoid over exposure of the patient, professionals and unnecessary stops of the equipment.

Bibliography

1. World Health Organization, http://www.who.int/es/
2. Panamericana Health Organization, http://www.paho.org
3. World Health Organization. WHO Position Paper on Mammography Screening, 2014. Disponible en: www.paho.org/cancer
4. Mamografia, Aspectos Operativos, Garantia y Control de Calidad – Radioproteccion, http://www.irpabuenosaires2015.org
5. Ministerio de Salud Pública y Bienestar Social, http://www.mspbs.gov.py.
6. Colectivo de Autores, “Protocolo Español de Control de Calidad en Radiodiagnóstico”, Revisión 1 (Aspectos Técnicos), SEFM-SEPR, 2002, pp. 17-21
7. MINSAP. 2001. Resolución Ministerial 19 “Guía de Seguridad. Requisitos Técnicos de Protección Radiológica en Radiodiagnóstico Médico”. La Habana, Cuba.
8. WICHES ZUÑIGA, M.; RUIZ MONSALVE, L.; HERNANDES, M.; Bioingeniería TomoIV. Fundamentos de instrumentación para la clinica y las radiaciones ionizantes.; 1ra Edición. Editorial Universidad de Antioquia. Colombia. 2007.
9. Control de Calidad en Mamografia. Protocolo elaborado en el marco de los proyectos regionales ARCAL - OIEA. Viena. 2006.