Comparison between the implementation of quality criteria of radiographic image in conventional and digital mammography equipments

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Abstract. The mammographic examination needs a strict quality control. A publication of the *European Commission* provides guidelines on quality criteria for the images of the breast, quantifying the quality obtained in the image. Following the recommendations of the *European Commission*, two kinds of mammographic equipments, at a same institution, were evaluated to compare the quality of the conventional and digital images. Besides of that, the Average Glandular Dose (AGD) and the Entrance Surface Dose (ESD) were measured by using an ionization chamber (Radcal, 6M) in the radiation beams of each equipment. The digital equipment fulfills more quality criteria than the conventional equipment, provided ESD values, AGD values and a rejection index lower than the conventional equipment. Therefore, the digital mammography can be considered more adequate than the conventional one, both for criteria analyses and for dose optimization.

KEYWORDS: quality criteria, dose optimization, mammography

1. Introduction

The main objective of a mammographic examination is the earlier detection of breast cancer. For this, the mammography system needs to produce the best possible image quality. Since the normal glandular tissue density and the diseased breast tissues density are very similar, the process requires images with high contrast[1]. Therefore, in order to have a good image quality, the glandular dose shall not increase. The best image quality has to be achieved with the lowest possible dose.

Nowadays, there are some different kinds of image acquisition; each one presents advantages and disadvantages. The great difference in image acquisition systems is between the film screen system and the digital system. The first one needs a processor to obtain the image, which does a large difference in the process, mainly in the contrast. The second system dispenses the processor; the image is obtained through detectors of the equipment and appears in the monitor in a few seconds after the examination.

The tendency, in a near future, is the change of all screen systems to digital ones; therefore, it is important to know if this method of image acquisition will really provide the best image quality with the lowest dose to the patient.

A publication of the *European Commission*[2] provides guidelines on quality criteria for the images of any part of the body, even for the breast, and in many projections, quantifying the quality obtained in the image.

The glandular tissue is the most radiosensible region of the breast. Therefore, it is not sufficient to measure just the Entrance Surface Dose (ESD), but it is important to measure the Average Glandular Dose (AGD) too.

The objective of this work was to compare the results of image quality criteria, ESDs, AGDs and the image rejection index between two kinds of mammography equipments, to verify which one presents the most efficient behaviour.

2. Materials and Methods

Following the recommendations of the *European Commission*[2], 260 exams were evaluated. They were realized in two mammography equipments in the same radiology department, using a Siemens Mammomat 3000 Nova system and a GE Senographe DS system. Two projections were analyzed: the Craniocaudal (CC) in 11 quality criteria and the Mediolateral Oblique (MLO) in 12 quality criteria (Table 1).

Table 1: Quality criteria of Craniocaudal and Mediolateral Oblique projections of the *European Protocol*[2].

Craniocaudal Projection	Mediolateral Oblique Projection
1 - Visually sharp reproduction of pectoral muscle at image margin.	1 - Pectoral muscle at correct angle.
2 - Visually sharp reproduction of retrograndular fat tissue.	2 - Inframammary angle visualized.
3 - Visually sharp reproduction of medial breast tissue.	3 - Visually sharp reproduction of craniolateral glandular tissue.
4 - Visually sharp reproduction of lateral glandular tissue.	4 - Visually sharp reproduction of retroglandular fat tissue.
5 - No skinfolds seen.	5 - Nipple in full profile, clear of overlaying breast tissue and/or indicated by marker.
6 - Symmetrical images of left and right breasts.	6 - No skinfolds seen.
7 - Visualization of skin outline with bright light.	7 - Symmetrical images of left and right breast.
8 - Reproduction of vascular structures seen through most dense parenchyma.	8 - Visualization of skin outline with bright light.
9 - Visually sharp reproduction of all vessels and fibrous strands.	9 - Reproduction of vascular structures seen through most dense parenchyma.
10 - Visually sharp reproduction of pectoral muscle margin.	10 - Visually sharp reproduction of all vessels and fibrous strands.
11 - Visually sharp reproduction of skin structure along the pectoralis muscle.	11 - Visually sharp reproduction of pectoral muscle margin.
	12 - Visually sharp reproduction of skin structure along the pectoralis muscle.

The measurements of the ESDs and AGDs were obtained, utilizing an ionization chamber (Radcal Corporation, 10x5-6M). During the measurements of AGD, phantoms with different thickness were utilized to simulate small, medium and large breasts[3, 4]. The medium values for each breast size were calculated based in real patient data. The ESDs were determined for the same thicknesses already quoted.

A study about rejection of images was also realized, identifying each cause. All examinations and all rejected images were collected along 2 months.

3. Results and Discussion

The percentage of exams that obey each quality criteria can be seen in Figure 1 (a) in the CC projection and (b) in the MLO projection.

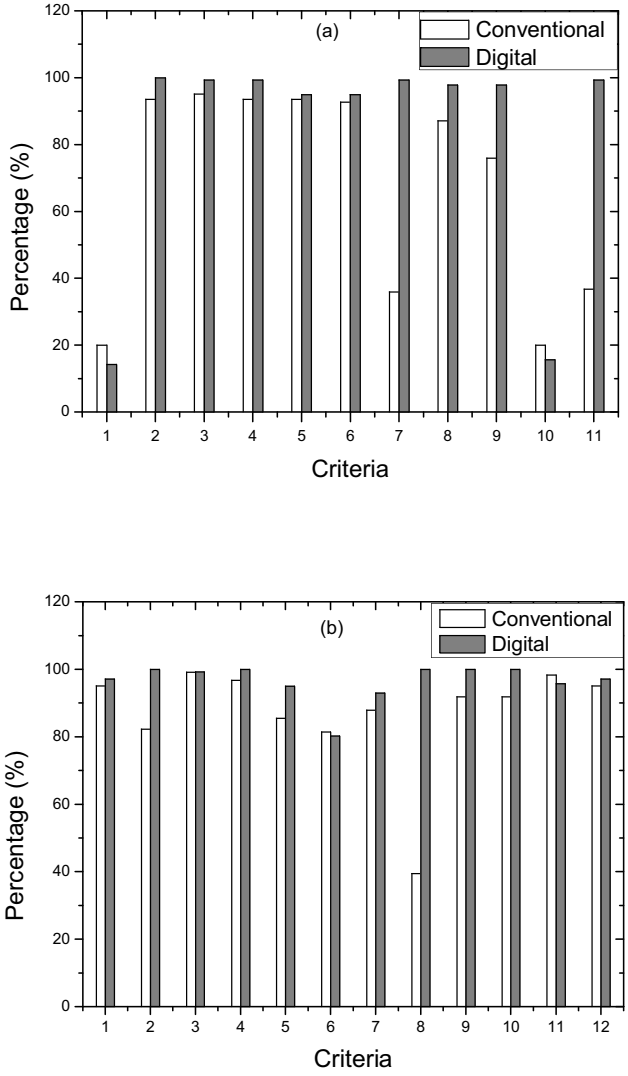

Figure 1: Percentage of radiographs fulfilling the criteria of the *European Commission*[2] in (a) craniocaudal and (b) mediolateral oblique projections for conventional and digital mammographic equipments.

In the CC projection, the 7 and 11 criteria showed agreement of almost 40% for the conventional equipment and 100% for the digital equipment. Both criteria evaluate the contrast of the image; the digital system showed the best results.

Criteria 1 and 10 are fulfilled in 20% in the conventional equipment, and in less than 20% in the digital equipment. The reason for this fact is the wrong patient position; it is not a problem of the equipment, but a problem of the procedure realized by the technician.

In the MLO projection, the 8 criterion is fulfilled almost 40% in the conventional equipment, and it is totally in accordance with the digital equipment. This criterion evaluates the contrast of the image too, as in the case of 7 and 11 criteria of the CC projection.

In the other criteria, both mammography equipments present similar results, but in the majority the digital equipment showed the best results.

The ESDs and AGDs measured in both equipments were determined for small (4.0 cm for Siemens and 4.3 cm for GE DS), medium (5.0 cm for Siemens and 4.5 cm for GE DS) and large (6.5 cm for Siemens and 6.3 cm for GE DS) breasts (Table 2).

Table 2: ESD and AGD values for three different thicknesses in each mammography equipment.

Siemens			GE DS		
Thickness (cm)	**ESD (mGy)**	**AGD (mGy)**	**Thickness (cm)**	**ESD (mGy)**	**AGD (mGy)**
4.0	9.58	1.76	4.3	4.30	0.95
5.0	10.07	2.05	4.5	4.30	0.99
6.5	19.72	3.31	6.3	7.88	1.48

In the Siemens mammography equipment, for all thicknesses, the ESDs are higher than twice the values in the digital equipment. These dose results show that the digital mammography equipment presents values always lower than the conventional one, in both cases of ESD and AGD.

For the image rejection analysis, in the case of the conventional mammography equipment, 5% of the films were rejected, while in the case of the digital equipment only 3 % of the images were rejected. Including the causes that do not depend on the equipment, the rejection index of the department is 6%. Fifteen main causes were detected (Table 3).

Table 3: Main causes of image rejection in the radiological department.

Causes of image rejection	Percentage (%)
Wrong patient position	29.0
Wrong parameters choice	14.0
Film processed without exposition	12.0
Film totally dark	10.0
Technical failure of darkroom / cassette	9.0
Processor failure	6.0
Tests	5.0
Patient movement	4.0
Inadequate photocell	3.0
Equipment failure	2.0
Desnecessary use of collimator	2.0
Wrong identification of patient data	1.0
Film not processed	1.0
Lack of breast mark	1.0
Useful	1.0

The main causes of rejection are: “wrong patient position” (29%), “wrong parameters choice” (14%), “film processed without exposition” (12%), “film totally dark” (10%), “technical failure of darkroom / cassette” (9%) and “processor failure” (6%). The other causes present values below 5%.

Despite of the digital equipment that presented the better results in all comparisons, all exams of big breasts have to be done in the conventional equipment. The digital equipments do not allow big breasts in their radiation field. Therefore, the conventional equipment is still essential in the department too.

4. Conclusion

The digital mammography equipment fulfills more quality criteria than the conventional one; it provided lower ESD and AGD values than the conventional system, and rejects less images than the conventional equipment. Therefore, the digital mammography can be considered more adequate than the conventional, both for criteria analyses and for dose optimization. On the other side, only the conventional equipment allows big breast examinations.

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REFERENCES

[1] KOPANS, D. B., Breast imaging, 2º Edition, Lippincott – Raven Publishers, Philadelphia, 135 (1998).
[2] EUROPEAN COMMISSION, European guidelines on quality criteria for diagnostic radiographic images, EUR 16260, Brussels: EC (1996).
[3] FURQUIM, T. A. C., Methodology for correlations between doses and detectability in standard mammographic images: aplication in Sao Paulo State. PhD Thesis, Instituto de Pesquisas Energéticas e Nucleares, Sao Paulo, Brazil (2005). (In Portuguese)
[4] WU, X., BARNES, G. T., TUCKER, D. M., Spectral dependence of tissue glandular dose in screen-film mammography. Radiology, 179, 143-148, 1991.