Mammographic oblique views 45°versus 60°: breast thickness, breast exposure and image quality

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Background. *Standard screening mammography includes two views: craniocaudal and mediolateral oblique. In the mediolateral oblique projection a central beam angle can varies between 30° and 60°.*

Patients and methods. *We compare the thickness of the compressed breast, time-current product, exposures and image quality in two different mammographic oblique views: 45°versus 60°. Our study population consisted of 33 women in whom additional 60°-films after standard 45°-films were obtained for the objective diagnostic reasons.*

Results. *The mean thickness of the compressed breast was significantly lower with an angle of 60° than with an angle of 45° (47.8 vs. 50.7 mm, p<0.01); the mean time-current product and the mean breast exposure were significantly lower with an angle of 60° than with an angle of 45° (42.6 vs. 46.7 mAs, p<0.01; 0.67 vs. 0.78 mGy, p<0.01). The difference in the image quality has not reached statistical significance (but it exists!).*

Conclusions. *By introducing 60°-films instead of commonly used 45°-films, mammograms of at least the same quality can be obtained with lower radiation dose, which is of great importance when we remind the great radiosensitivity of glandular breast tissue.*

Key words: mammography, radiation dosage; thermoluminiscent dosimetry

Introduction

Standard mammography includes two views: the craniocaudal and the mediolateral oblique.[1,2] In the mediolateral oblique projec-

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tion a central beam angle can vary between 30° and 60°, with 45° routinely used for the majority of patients.[3] Mammography may include supplemental views tailored to a specific problem. Although the use of mammography has been increasing rapidly, contributing to the breast radiation burden, the benefits of mammography substantially outweigh the risk of radiation induced carcinoma, which is small but inevitable.[4,5] The study was aimed to compare the thickness of the compressed breast, time-current product (mAs), exposures and image quality in two different

mammographic oblique views: 45°versus 60°.

Patients and methods

Our study population consisted of 33 women in whom additional 60°-films after standard 45°-films were obtained. Additional 60°-films were obtained for clarifying suspect or indeterminate focal lesions or microcalcifications. Additional oblique films were done after the informed consent (we explained to our patients the potential benefit of early cancer detection versus a small carcinogenic risk related to the additional exposure). All our patients were ≥40 years old. Women with breast implants, prior lumpectomy and radiotherapy were excluded from the study.

Film-screen mammography was done with Mammomat 300 (Siemens, Erlangen, Germany) with Mo-anode and 0.03 Mo-filtration. A film-screen combination MIN-2000 (Kodak, Windsor, CO, USA) and an automatic processor for developing Curix 400 (Agfa Gevaert N.V., Brussels, Belgium) were used. To avoid bias, additional 60°-films were obtained and developed under the same conditions several minutes after 45°-films. This included the same positioning technique, compression force (15 kp), tube voltage, AEC (automatic exposure control) detector position and the same radiographer who was unaware of the purpose of the study.

Exposures were measured using thermoluminescent dosimeters (TLD), which were positioned at the breast support plate as near as possible to the nipple, but not to obscure any part of the breast tissue. TLDs used for exposure measurements were TLD-700 (LiF:Mg, Ti) lithium flouride TLD (manufactured by Harshaw), 3x3 mm chips 0.9 mm thick, which were packed in pairs of two in rubber holders. TLDs were annealed prior to each irradiation (at 400°C for one our + 100°C for 2 hours (calibration). Before the readout, the external (100 °C for 20 min) and the internal (100 °C for 6 hours) pre-heat treatment for all TLDs were used.[6] Reading of TLDs was performed by using Toledo 654 (Pitman/Winten) system. The digital readout of compressed breast thickness (mm) and time-current product (mAs) was recorded at the mammography unit control table. The contrast and spatial resolution were subjectively assessed using 0-3 scale (0=unsatisfyed, 3=excellent) by two skilled radiologists who were unaware of the view angle, and who analysed the mammograms independently.

For quantitative data (the breast thickness, time-current product and exposures) mean values and the standard deviation were calculated. The significance of differences was assessed by means of the differention method and the Student t-test. For qualitative data (contrast and spatial resolution) an average score was calculated (0-3 scale). The significance of differences was assessed by means of the McNemar χ^2-test.

Results

The study was performed on 33 women aged between 40 and 71 years (mean age was 51.2 +/- 8.8 years), in whom additional 60°-films after standard 45°-films were obtained. The mean thickness of the compressed breast was significantly lower with an angle of 60° than with an angle of 45° (47.8 versus 50.7 mm, p<0.01) (Table 1). The mean time-current product (mAs values) was significantly lower with an angle of 60° than with an angle of 45° (42.6 versus 46.7 mAs, p<0.01) (Table2). The mean exposure was significantly lower with

Table 1. Thickness of the compressed breast (in mm): 45°versus 60°

Mammographic mediolateral oblique view	45°	60°
Mean	50.7	47.8
S.D.	11.5	10.7
Significance	p<0.01	

Table 2. Time-current product (mAs values): 45°versus 60°

Mammographic mediolateral oblique view	45°	60°
Mean	46.7	42.6
S.D.	17.1	15.2
Significance	p<0.01	

Table 3. Breast exposure (in mGy): 45°versus 60°

Mammographic mediolateral oblique view	45°	60°
Mean	0.78	0.67
S.D.	0.31	0.27
Significance	p<0.01	

an angle of 60° than with an angle of 45° 0.67 *versus* 0.78, p<0.01) (Table 3). The average spatial resolution was insignificantly better with an angle of 60° than with an angle of 45° (0-3 scale; 1.53 versus 1.37, p>0.05). There was no difference in the average contrast resolution (0-3 scale; 1.50 *versus* 1.51).

Discussion

Due to the great radiosensitivity of glandular breast tissue there is small but inevitable risk of inducing breast cancer during mammography (6.6 radiation induced breast cancers per million women per year per 0.01 Gy per all western women exposed after age of 20).[7] The incidence of radiation induced breast cancer depends on the radiation dose and the age at the exposure. It progressively decreases after the age of 40 years because of the lower proportion of glandular breast tissue and fatty substitution.[8] The minimal latent period was estimated to 10 years from the radiation exposure until breast cancer develops and it was unaffected by dose.[7,9] A linear dose-response curve without a threshold is generally accepted for the radiation induced breast cancer.[8,10]

It is obvious that a theoretical carcinogenic risk from mammography appears to be negligible compared to benefits of early cancer de-

tection, even in women beginning annual screening at age of 35 and continuing until age 75 years the benefit widely outweigh the risk.[4] Regardless of this »theoretical risk« of carcinogenesis, we consider that efforts made to reduce radiation dose during mammography are welcome, especially when we take into account rapidly increased number of women attending to the mammographic examination. According to the prior statement, intention of this study was to indicate a way to reduce radiation dose during mammography, without impairing image quality.

Routinely used 45°-films were proved to be suitable for the majority of patients considering different body constitution and breast types. We were curious, what will happen with the thickness of the compressed breast, time-current product, exposure and image quality if we choose another central beam angle? It is well known that the proper breast compression is a prerequisite for obtaining mammograms of satisfying quality and for reducing radiation dose. Gentry and DeWerd state that exposure dose and compressed breast thickness were linearly correlated.[9] It reinforces the importance of the firm breast compression during mammography in order not only to reduce the exposure but also to achieve some additional benefits affecting image quality: lower scatter, reduced motion artefacts, reduced geometric unsharpness (shorter object-film distance), reduced breast tissue superimposition and equalised breast thickness.[11,12] If we intend to obtain good image quality with as low as possible radiation dose a central beam angle, which allows a better breast compression, should be chosen.

Considering the radiation dose measurement two approaches are available: recording the exposure parameters (tube voltage, focus-film distance, mAs, the thickness of the compressed breast) or the direct assessment using TLDs, which was performed in our study.[13] In a previous study[14] the authors es-

timated the breast irradiation indirectly recording exposure parameters and found differences in favour of 60°-films which agrees with the results of this study.

In both studies »fixed kVp protocol« was used: the tube voltage was constant and the variable breast thickness was compensated by mAs values. Mc Parland and Boyd investigated the patient's dose in »fixed kVp protocol« *versus* »variable kVp protocol« and found a lower radiation dose for thicker breast when »variable kVp protocol« was used, with a small reduction in image quality.[15] In spite of this, we used »fixed kVp protocol« because we consider that the patient's dose reduction should not interfere with the image quality.

We are aware of the possible shortages of our study: We did not assess the mean glandular dose (MGD) which is of the greatest importance in assessing the carcinogenic risk. But, when we are aware of the linear correlation between MGD and the exposure, we can assume that by reducing exposures we will reduce MGD and the carcinogenic risk, as well. We also did not take into consideration the patient's body constitution and the constitution of the breasts. It was found in a previous study that the breast compressibility with an angle of 60° was the best in thin women with the pendulous breast.[14]

We conclude that 60°-films were obtained with better breast compressibility comparing to 45°-films, which results in lower time-current product and exposure whereby the image quality was the same or even better. By introducing 60°-films instead of 45°-films the mammograms of at least the same quality can be obtained with a lower radiation dose and a lower carcinogenic risk.

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