MEASUREMENT OF SOME DOSIMETRIC PARAMETERS FOR TWO MAMMOGRAPHY SYSTEMS USING THERMOLUMINESCENCE DOSIMETRY

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Introduction: Mammography is at present the most effective means of detecting early-stage breast cancer. Over the past 30 years many significant technologic improvements have been made in mammographic equipment in order to produce an image with high contrast, high spatial resolution, and with minimal radiation dose possible. Two dosimetric quantities are important in mammography: Entrance-Surface Dose (ESD) and Relative Depth Dose (RDD). The former involves a measurement in air under scatter-free conditions (incident air kerma) and the application of a backscatter factor (BSF), while the latter is obtained from the knowledge of the relationship between Entrance-Surface Dose and absorbed dose to tissue at depth. Experimental determination of these quantities can contain significant systematic errors due to the energy response and the size and location of the dosimeter used. In this work, we used LiF: Mg: Ti (TLD-100) to investigate the dependencies of the BSF, ESD and RDD on the geometric and spectral conditions, corresponding to the most radiographic techniques employed in conventional and computer mammographic procedures, i.e., beam qualities in the range of 0.35 mmAl to 0.43 mmAl, tube voltages from 25kV to 32kV, focus-film distances from 56cm to 66cm, and three field sizes were evaluated. Our results were compared with those previously published obtained through Monte Carlo simulation, ionization chambers and TLD dosimeters.

Materials: Two types of mammography equipments were used in this study. The first was a Senographe DMR (GE Medical System). This unit allows selecting several anode/filter combinations, as Mo/Mo, Mo/Rh and Rh/Rh. The second equipment was a Mammomat 3000 (Siemens,). The possible anode/filter combinations for this unit are Mo/Mo, Mo/Rh, W/Rh. TLD-100 Harshaw chips (3.1×3.1×0.89 mm) were used. The dosemeters were annealed in air at 400 °C for 1 h followed by 2 h annealing at 100 °C. The chips were irradiated within two days after annealing. TL reading was performed, approximately 24 h after irradiation, in a nitrogen atmosphere using a Harshaw model 2000 reader at a heating rate of 10 °C/s, integrating from room temperature to 400 °C. TLD-100 was used in this work since it offers an atomic number close to the tissue and small size, characteristics advantageous for this type of measurments. The breast is simulated by a PMMA phantom, comprising of semicircular slabs of thickness 10mm and 100mm of radius.

Results: The results obtained in this work show that the ESD values decrease with increasing tube potential (or effective energy of the beam) and increase with increasing phantom thicknesses. The backscatter factors increase with increasing phantom thicknesses (about 1% for each 1cm). The backscatter factors at different beam qualities, expressed in terms of the half-value layer of aluminum, are plotted in Figure 1, together the available published data. It can be seen that there is a good agreement between these data.

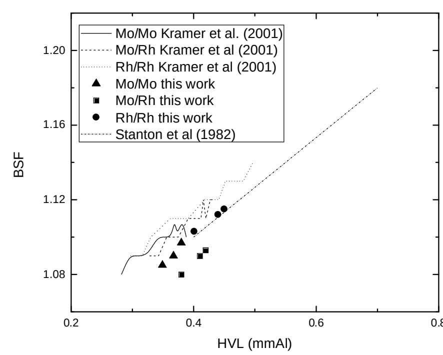

Figure 1: BSF vs HVL. Previously reported values are shown for comparison.

Relative depth dose curves decrease practically exponentially with the thicknesses and depend strongly on x-ray beam quality.

Conclusions: The experimental values obtained with the TLD-100 chips show a satisfactory agreement with other studies and allow studying the dependency of the all dosimetric quantities with the half-value layer (HVL), tube voltage, anode-filter combination, field size, focus-film distance and breast thickness.

References:

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