Average Glandular Dose In Mammography

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Abstract : The average glandular dose(AGD) is determined by the breast entrance skin exposure, x-ray tube target material, beam quality(half-value layer), breast thickness, and breast composition. Almost breast cancer always arises in glandular breast tissue. As a result, the average radiation absorbed dose to glandular tissue is the preferred measure of the radiation risk associated with mammography. If the normalized average glandular dose is known, the average glandular dose can be computed from the product of the normalized average glandular dose and breast entrance skin exposure. In this study, AGD was calculated by the breast thickness and various x-ray energy(HVL) in 50% glandular 50% adipose breast by Mo.-Rh. assembly. AGD is 84 mrad in compressed 5 cm breast. These results show that as increasing the breast thickness, dose also increases. But as increasing the x-ray tube voltage, dose decreases because of high penetrating ratio through the object. But high tube voltage is reducing the subject contrast. From this result, we have to consider the trade-off between subject contrast of image and dose to the patient and choose proper x-ray energy range.

Key words : Average Glandular Dose, Entrance Skin Exposure

Ⅰ. Introduction

The average glandular dose in mammography is determined by the breast thickness, breast composition, x-ray tube target material, beam quality(Half-Value-Layer), and entrance skin exposure.

For currently used target-filter source assemblies are different in dose of 10% or more in estimating the average glandular dose with different x-ray system itself.

Almost breast cancer always arises in glandular breast tissue. As a result, the average radiation absorbed dose to glandular tissue is the preferred measure of the radiation risk associated with mammography.

Ⅱ. Theory and methods

To determine the average glandular dose, two parameters are needed. If the normalized average glandular dose D_{gN} (the average glandular dose per unit entrance skin exposure, grays per coulomb per kilogram) is known, the average glandular dose D_g (grays) can be computed from the product of D_{gN} and the breast entrance skin exposure X_{ESE} (coulombs per kilogram). That is,

$$D_g = D_{gN} \cdot X_{ESE}$$

Normalized average glandular dose is computed by Monte Carlo simulation of x-ray photon transport in breast tissue[4]. In our previous study, the x-ray spectra were used and obtained by means of the constant potential molybdenum target x-ray spectra model[5].

To determine the average glandular doses that would result in clinical common practice 3, 5, and 7 cm thicknesses of various composition of breast phantom were imaged for the target-filter combination and the x-ray tube potentials of interest of 25, 27, and 29 kVp.

Mo.-Rh. assembly is adopted and 100% glandular, 50%-50%, and 100% adipose breast were imaged with different breast thicknesses and various x-ray tube voltages. It can be possible to measure different feature of each patient.

III. Results

Figures depict the calculated AGDs with various breast thicknesses and for comparison, different x-ray tube voltages are included.

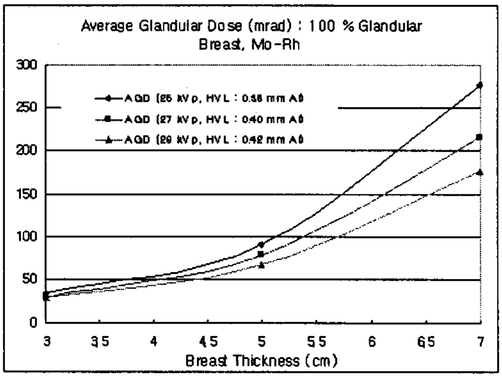

Figure 1 Average Grandular Dose (AGD) to 100 % Glandular Breast Tissue, Mo-Rh.

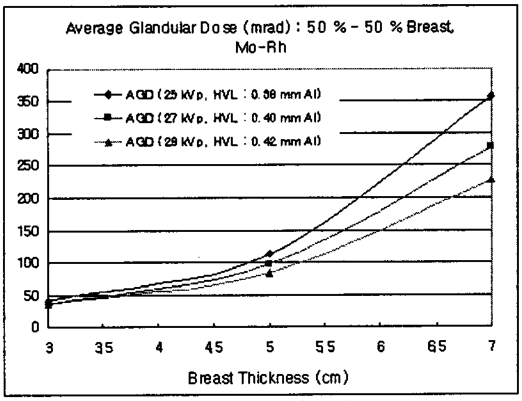

Figure 2 Average Grandular Dose (AGD) to 50 % Glandular - 50 % Adipose Breast Tissue, Mo-Rh.

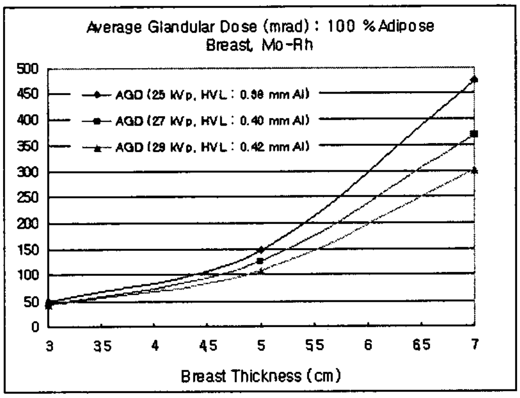

Figure 3 Average Grandular Dose (AGD) to 100 % Adipose Breast Tissue, Mo-Rh.

Figure 1, 2, and 3 show that various types of average grandular dose(AGD). Figure 1 represents AGD as the breast thickness and various x-ray energy(HVL) in 100% glandular breast by Mo.-Rh. assembly. AGD is 67 mrad in compressed 5 cm breast. Figure 2 represents AGD as the breast thickness and various x-ray energy(HVL) in 50% glandular 50% adipose breast by Mo.-Rh. assembly. AGD is 84 mrad in compressed 5 cm breast. Figure 3 represents AGD as the breast thickness and various x-ray energy(HVL) in 100% adipose breast by Mo.-Rh. assembly. AGD is 108 mrad in compressed 5 cm breast. As the breast thickness is increased, dose also increased. But as the x-ray tube voltage is increased, dose also decreased because of high penetrating ratio through the object. But high tube voltage is reducing the subject contrast. Thus, we have to consider the trade-off between subject contrast of image and dose to the patient and choose the proper x-ray energy range.

IV. Discussion

Apparent thing is the increasing of the average glandular dose as the breast thickness. In figure 2, the AGD of 7 cm breast is abut 350 mrad. That is 7 times than 3 cm breast thickness(50 mrad).

As the result, the adipose breast was absorbed more dose than glandular breast. Normally, 100% adipose or 100% glandular breast can be a part of breast.

D_{gN} is decreased for 1-R entrance skin exposure in same x-ray tube voltage with same HVL(mm Al) for compressed breast thickness is increased. Properly, as the x-ray tube voltage is increased, then D_{gN} is increased for same HVL(mm Al) but the value is not quite numerous. In imaging view, not only high x-ray tube voltage but also irradiating time is important. If the applying time will be increased subject contrast also is increased but it will affect patient.

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