

## Letter to the Editor

# Investigation of Mean Glandular Dose in Diagnostic Mammography in China\*



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A survey of 420 exposures of mammography was performed with the parameters recorded. Entrance skin air kerma (ESAK) was measured and the mean glandular dose (MGD) was calculated according to the Dance's formula. Correlation analysis showed that several factors could affect the MGD level. Mann-whitney test and Non-parametric ANOVA analyses were used to compare the MGD level grouped by view type and radiographic systems. No significant difference was found in MGD between the craniocaudal (CC) group and the mediolateral oblique (MLO) group. The MGD level was higher in the CR group than in the other two groups. MGD was positively correlated with the compressed breast thickness (CBT). MGD varied with the half value layer (HVL) and increased first then decreased. The mean MGD level in China is about 1.6 mGy and is lower than the guidance level in the International Basic Safety Standards (IBSS).

Breast cancer is the most common cause of cancer-related deaths in women in Europe<sup>[1]</sup>. Early detection can substantially reduce its mortality. It was reported that mammography is the most effective procedure for screening breast cancer. It is important to ensure that the equipments can provide sufficient diagnostic information at a reasonably low radiation dose.

In the 'European Protocol on Dosimetry in Mammography', various dosimetric methods and quantities are described, which include entrance skin air kerma (ESAK), entrance skin dose (ESD) and mean glandular dose (MGD). MGD is the most appropriate dosimetric quantity to predict the risk of radiation-induced carcinogenesis. MGD cannot be directly calculated, but can be calculated from ESAK using the appropriate conversion factors<sup>[2-3]</sup>.

Studies on MGD are reported in Europe and Asia<sup>[4-5]</sup>. However, few are available in China. This study was to investigate the technical parameters of

mammography currently used in China, analyze the MGD influencing factors, and reveal MGD during performing mammography in China.

## Mammography Equipment

Twenty-one pieces of equipment (17 from public hospitals and 4 from private hospitals) were included in this study.

One mammography system was selected from each sample hospital. Of the 21 pieces of equipment, 8 were DR system, 8 were CR system, and 5 were SFR system.

## Patient Data

A total of 420 operations of mammography were performed in this study. Forms containing patient information (including age and weight) and mammographic parameters (including voltage, Output) were filled in by the technicians who performed the mammography. The compressed breast thickness (CBT) was measured with a ruler. The mammography data were analyzed.

## Calculation of MGD

The MGD level for each acquired image was calculated as previously described<sup>[2-3]</sup> according to the formula  $MGD = K \cdot g \cdot c \cdot s$  (1)

Where  $K$  is the entrance surface air kerma (ESAK) at the upper surface of breast,  $c$  and  $g$  represent the X-ray beam spectral characteristics and assumptions regarding the breast glandularity,  $s$  is the factor used to correct the differences in X-ray spectra generated by anode target/filter other than Mo/Mo.

ESAK and half value layer (HVL) data were recorded with a QA radio-dosimeter (model: Barracuda; RTI Corporation, Sweden) which was calibrated in the traceable Secondary Standard Dosimetry Laboratory at Shanghai Institute of

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Measurement and Testing Technology (SIMT). Two sets with a 99.9% purity aluminum filter were used to measure HVL which was corrected according to the inverse-square law for each individual breast thickness.

### Statistical Analysis

The factors influencing MGD were analyzed by correlation analysis. The categorical variables were analyzed by nonparametric correlation analysis. The homogeneity of CBT and MGD in CC group and MLO groups was analyzed by unpaired Student's *t* test and Mann-Whitney test, respectively. Three kinds of radiographic system were compared by Kruskal-Wallis test.

### Descriptive Statistics

The mean MGD was about 1.6 mGy, and the range of the MGD is from 0.39 mGy to 5.01 mGy. The average MGD was similar to that reported in previous studies<sup>[5-6]</sup>. However, it is higher than that reported in a Greece study<sup>[4]</sup> and lower than that in a UK study<sup>[7]</sup>.

The range and distribution of CBT in this study were similar to those in a Malaysia study<sup>[5]</sup>. The mean CBT was lower in this study than in other studies<sup>[8-9]</sup>.

Patient information and technical parameters are shown in Table 1.

### Correlation Analysis

Correlation analysis showed that the MGD level was affected by 3 factors: output (mAs), CBT and type of radiographic systems.

### Relation between MGD and View Types

MGD and CBT in CC and MLO groups were analyzed. Since the variable MGD could not satisfy

the normality assumption, the difference in MGD and CBT between the two view types was verified by Mann-Whitney *U* test and unpaired Student's *t* test, respectively. The mean CBT in MLO and CC groups was 4.30 cm and 3.89 cm, respectively, 10% higher in the MLO group than in the CC group ( $P<0.05$ ). However, no significant difference was found in MGD between the two groups.

It has been shown that the view type is one of the influencing factors for MGD in some previous studies<sup>[4,10]</sup>. The median MGD for MLO (1.47 mGy) was closely related with the CC view (1.45 mGy). However, the CBT between the MLO group and the CC group differed greatly. It was reported that the pectoral muscle was denser than the rest breast muscles, which may be a reasonable explanation for this phenomenon<sup>[4]</sup>.

### Radiographic Systems

The difference in 3 kinds of radiographic systems was analyzed by Kruskal-Wallis test, showing that the mean MGD was higher in the CR group than in other two groups. No significant difference was observed in the mean MGD detected by the DR and SFR systems.

Mann-Whitney *U* test showed that MGD was higher in CR system than in SFR and DR systems, which is similar to a previous study<sup>[7]</sup>. However, the sample size of SFR system was so small (5 SFR systems) that the confounding bias affected the result, indicating that more data of SFR system are needed to establish the relation of MGD with SFR and DR systems.

### Relation between MGD and CBT

The samples were divided into 6 groups according to their CBT. Figure 1 shows the relation between MGD and CBT.

**Table 1.** Patient Information and Technical Parameters

Information and Parameters	Median	25% Values	75% Values	Mean	SD	Range
Age (y)	45	42	49	46.1	9.1	23-81
Weight (kg)	62	56	65	58	15.1	45-84
CBT (cm)	4.1	3.0	5.0	4.1	1.2	1.3-7.5
Tube (kV)	28	26	30	28.5	2.8	22-35
Output (mA s)	58	33	87	66.3	39.9	12.1-278
ESAK (mGy)	5.6	4.0	8.7	6.8	4.3	1.12-25.8
MGD (mGy)	1.4	1.1	2.0	1.7	0.8	0.39-5.01

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