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JOINT AAPM | COMP MEETING

Is Average Body Diameter Helpful in Choosing Exposure Technique in PA Chest X-Ray?

H. A. Ai, Ph.D.
Department of Diagnostic Radiology and Nuclear Medicine, Rush University Medical Center, Chicago, IL, United States 60612

RUSH

INTRODUCTION

In 2019, 57% of all Chest X-ray exams performed at our institutions were performed on portable X-ray units, where the selection of imaging technique (especially mAs) is dependent on the experiences of the radiographer and can sometimes lead to: 1) over-exposure, which subjects the patient to unnecessary amount of radiation, or 2) under exposure, which can produce noisy images that requires a repeated exam. A quantitative metric guiding the selection of imaging technique to produce optimal amount of exposure is therefore desirable. In this study, the Average Body Diameter, calculated from patient's weight and height assuming a cylinder model is investigated to see whether it can serve as such a metric.

METHOD

Information of all clinical PA chest X-ray exposures from an AGFA DX-D600 stationary digital radiography unit in 2019 were exported via Radimetrics Enterprise Platform. The AEC of this unit has a COV of less than 0.1% during the annual physics evaluation. Exposures meeting the following criteria were considered "optimal" and selected for analysis: 1) Deviation index is between -1 and 1 (target exposure index = 250); 2) Source to Image distance is within 2.5 cm of 180 cm; 3) kV = 120; 4) Patient age is at least 18, with both height and weight information available. A total of 200 PA chest exposures from 200 different patients were selected (Male = 78, Female = 122).

Using the model of a cylinder and assuming patient density is 1 g/cm^3, the average body diameter of each patient is estimated using formula

$$Weight = \rho\pi(\frac{1}{2}D)^2 \times Height,$$

Which gives

$$D = 2\sqrt{\frac{Weight}{\rho\pi \times Height}}$$

Linear regression analysis was performed between average body diameter and $\log_{10}$(mAs), as well as between body mass index (BMI, Weight/Height^2) and $\log_{10}$(mAs) for all exposures.

RESULTS

Average body diameter was found to have a slightly higher correlation with $\log_{10}$(mAs) than BMI (R^2: 0.603 vs 0.512, RMSE: 0.114 vs 0.127), indicating that it is a better quantitative metric predictor of optimal mAs for PA chest radiography. Despite having a greater range of both weight and diameter, the correlation of average body diameter with $\log_{10}$(mAs) for female patients is notably higher than that for male patients (R^2: 0.706 vs 0.459, RMSE: 0.102 vs 0.117), possibly because female patients in this study have more consistent body composition.

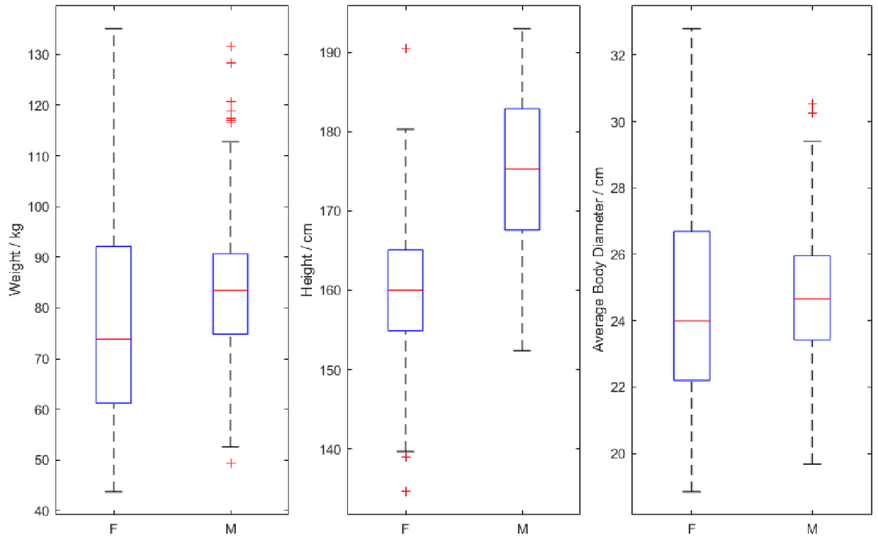

Fig.1 Distribution of height (cm), weight (kg) and calculated average body diameter (cm) for patients included in the study. Female patients have notably greater range in weight and diameter than male patients.

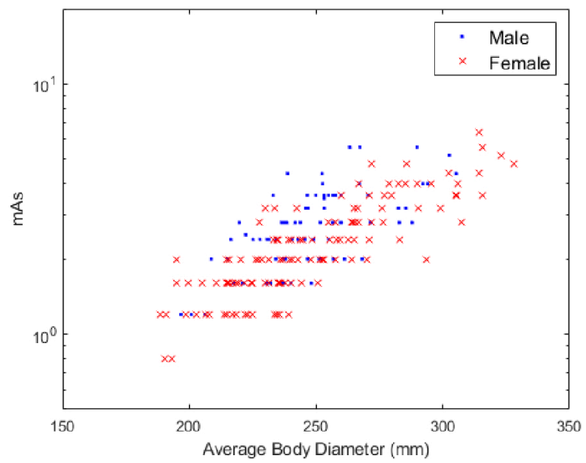

Fig. 2 mAs vs Average Body Diameter for male (N = 78) and female (N=122) patients from exams selected in this study.

Table 1. Results of the linear regression analysis between calculated average body diameter and log10mAs, as well as between body mass index and log10mAs.

	$\log_{10}$mAs vs Average Body Diameter, both gender (N=200)	$\log_{10}$mAs vs Average Body Diameter, Male (N=78)	$\log_{10}$mAs vs Average Body Diameter, Female (N=122)	$\log_{10}$mAs vs Body Mass Index, both gender (N=200)
R^2	0.603	0.459	0.706	0.512
RMSE	0.114	0.117	0.102	0.127
X_1 (Slope)	0.0047982	0.0046785	0.0048128	0.018117
X_0 (Intercept)	-0.81943	-0.74262	-0.85318	-0.16575

CONCLUSIONS

In exams with appropriate exposure levels, average body diameter has stronger correlation with $\log_{10}$(mAs) than BMI in our study, especially in female patients, and therefore is a better quantitative metric in the determination of mAs for PA chest radiography. However, the overall weak correlation indicates that additional information is likely needed when considering exposure settings in clinical practice.

CONTACT INFORMATION

For any further questions, please contact
Hua_A_Ai@rush.edu,