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PRACTICAL COMPARISON OF DIFFERENT PATIENT'S DOSE ESTIMATION METHODS DURING MEDICAL X-RAY PROCEDURES

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Medical Physics in the Baltic States 14 (2019).
Proceedings of International Conference "Medical Physics 2019".
7-9 of November 2019, Kaunas, Lithuania.

Introduction

- Establishing of national diagnostic reference levels (DRL) for the most common medical x-ray procedures is one of the major and most important steps to optimise patient‘s doses.
- Lithuania is one of the countries that has established DRL’s based on their own survey.
- Until 2016 survey had to be performed based on entrance surface dose (ESD) measurements.
- In 2016 Radiation Protection Centre released the „*Methodical recommendations of patient‘s dose estimation during medical x-ray procedures*“.

The aim

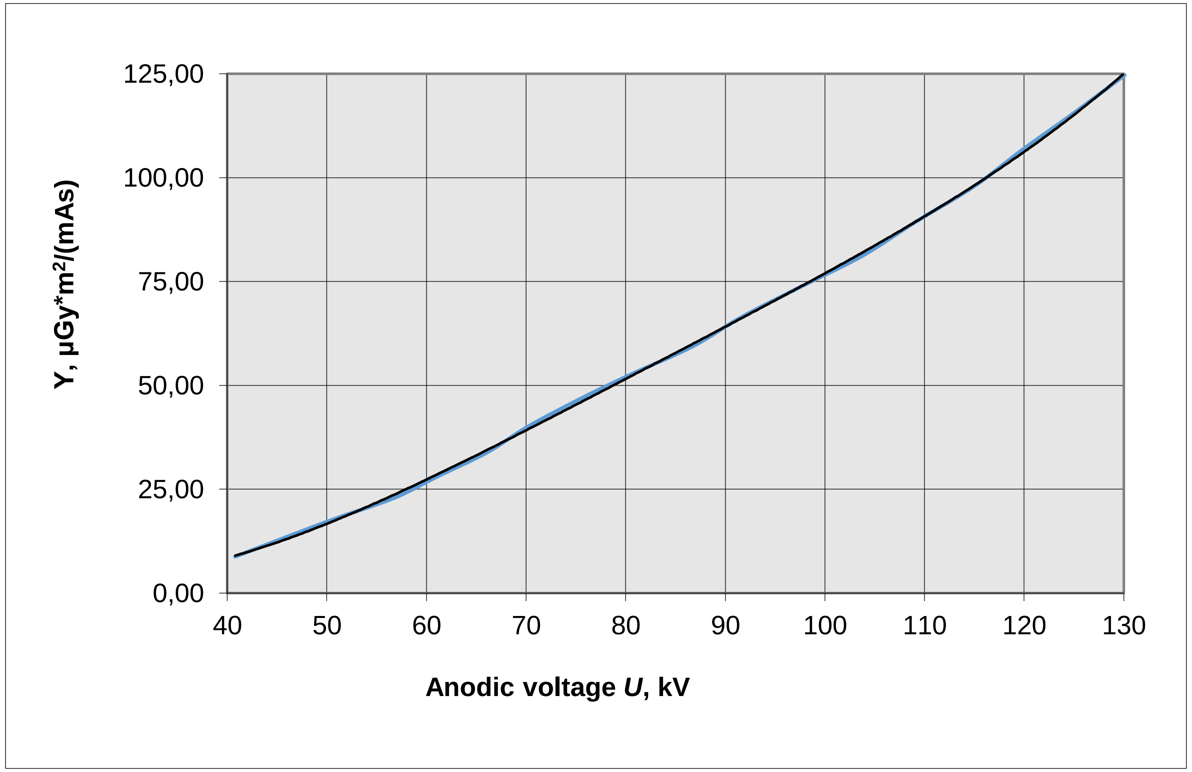
- The aim of this study is to check reliability of data collected by different patient‘s dose estimation methods for using it for establishing national DRL‘s.

Keywords: patient‘s dose, entrance surface dose (ESD), dose-area product (DAP), TLD dosemeter, medical x-ray diagnostic, diagnostic reference level (DRL).

Methodology

- The study was performed on Shimadzu RadSpeed Pro EDGE X-ray machine
- First phase of the work was to determine the radiation output dependence on voltage.
- Second phase of the study involved measurement of ESD and DAP and checking reliability of readings.

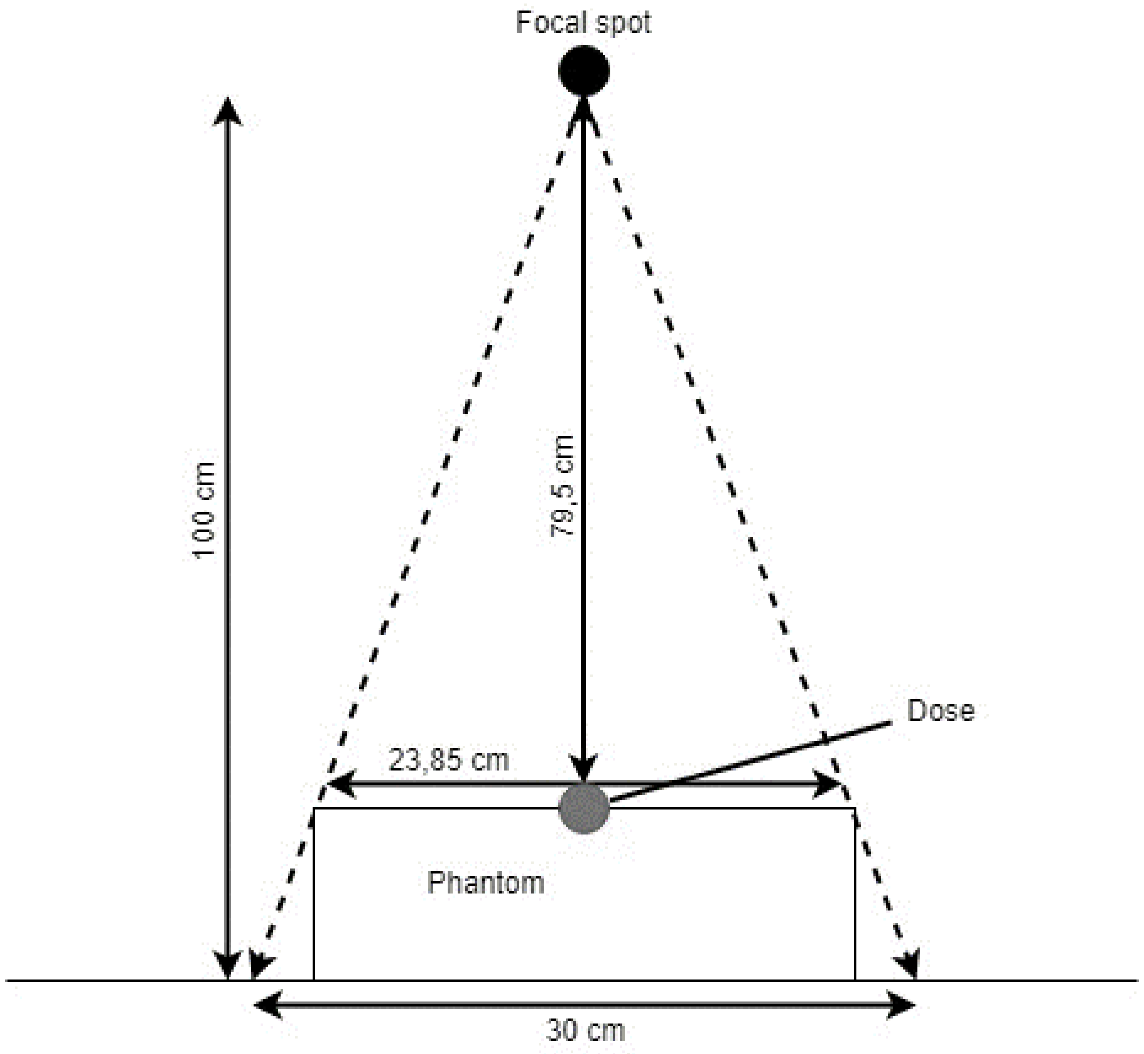
- Unfors Multi-O-Meter 517 L, No. 128100 was used
- Radiation field of 30 cm x 30 cm
- Distance = 1 m
- Current – 5 mA
- Voltage range – 40 to 125 kV
- 20 exposures were performed

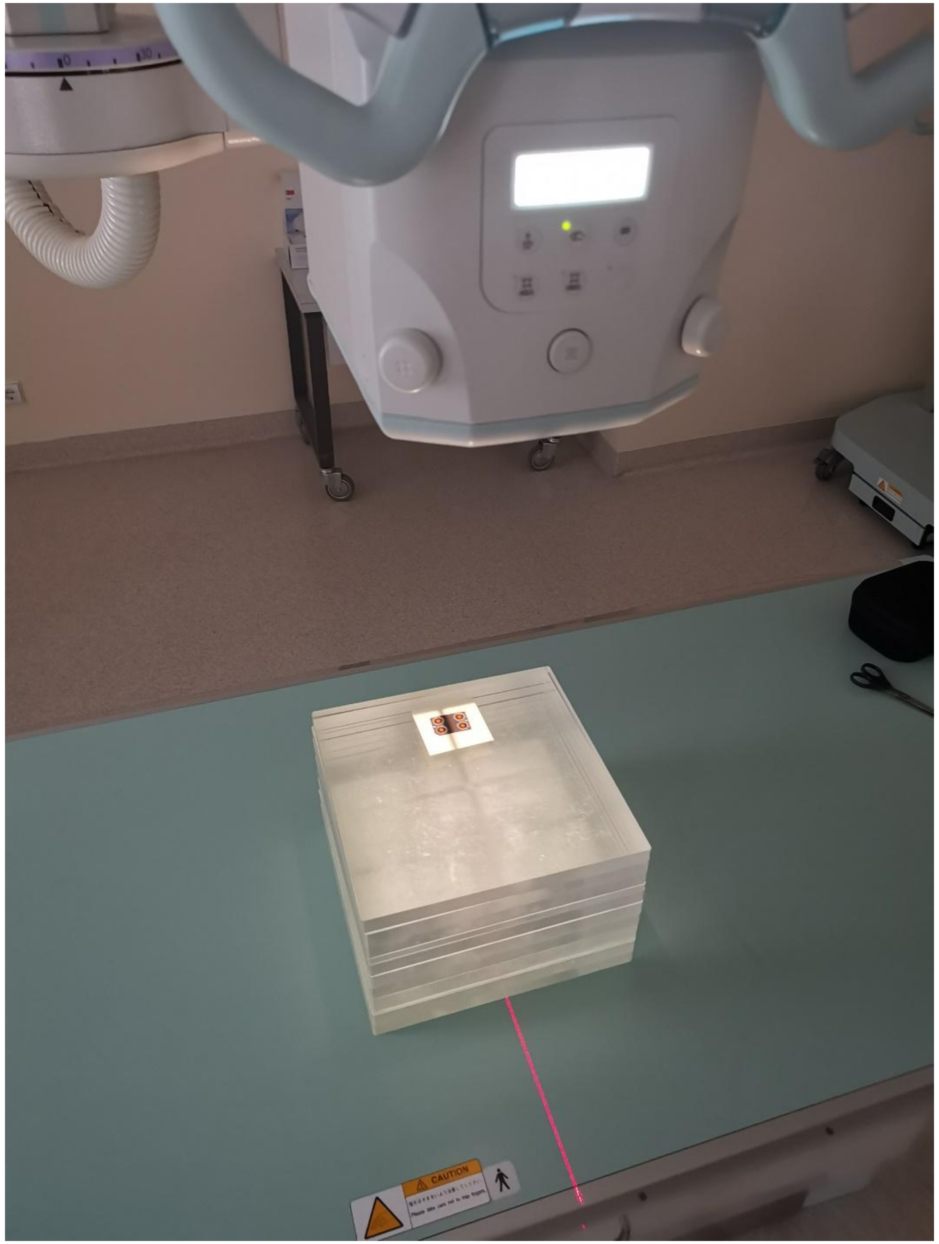


$$Y(d) = \frac{(K_I \times d^2)}{(I_V \times t_V)}, mGy \cdot m^2 \cdot (mA \cdot s)^{-1}$$

K_I – measured dose (Kerma) value, d – distance between the x-ray tube and detector, in meters; I_V – nominal value of current strength, in milliamps; t_V – nominal exposure duration, in seconds.

Study scheme




CAUTION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Entrance surface dose (ESD) calculation

- Kerma on phantoms surface calculation

$$K_{P,i} = \frac{Y(d)Itd^2}{d_{FSD}}$$

Y(d) – radiation output at a distance d, mGy · m^2 · (mA · s) $^{-1}$, I - average power consumption, milliamps, t - average exam time, in seconds, d - distance between the x-ray tube and the detector, in meters, d_{FSD} - the distance between the x-ray tube and the patient, in meters

$$ESD = K_{P,i} \times B$$

$K_{P,i}$ – Kerma at patients surface, mGy, B – coefficient of scattered radiation that can be found in „Radiation Protection, No 154 – European Guidance on Estimating Population Doses from Medical X-Ray Procedures".

Dose area product calculation

$$DAP = DAP_R \times k$$

DAP_R - the displayed value of the DAP meter installed in the X-ray equipment, $mGy \cdot cm^2$,
k - the correction factor established during the measurement.

$$k = \frac{DAP_M}{DAP_R}$$

Here k is the correction factor, DAP_M is the measured value of the calibration DAP meter during the quality control, $mGy \cdot cm^2$, DAP_R value is displayed in the X-ray equipment DAP meter, $mGy \cdot cm^2$.

Results and discussion

Evaluation method	**Mean ESD value, µGy**	***95 % confidence interval (ESD)***
$D_{79.5cm}$ calculation	396.1	±3.6
ESD calculation	566.4	±5.1
TLD measurement	323.5	±19.1

The study has shown that evaluating ESD values, calculated values are always higher because the result is inflated by evaluation coefficients and with the help of TLD dosimeters ESD values are closer to calculated kerma at the distance of 79.5 cm ESD.

A comparison of the results of the experimental and estimated evaluation of DAP values

Evalutaion method	Mean DAP value, µGy•m²	*95 % confidence interval (DAP)*
$DAP_{estimated}$ (X-ray machine console readings)	20.68	±0.04
$DAP_{experimental}$ (based on the calculated kerma values from the radiation output curve)	22.52	±0.21
$DAP_{experimental}$ (based on the dose values obtained from measurements from the TLD)	18.40	±1.09

- Very small variation of X-ray console readings
- $DAP_{experimental}$ values are higher
- Correction coefficient of 1.089

Conclusions

- Evaluating ESD values, calculated values are always higher because the result is inflated by evaluation coefficients and with the help of TLD dosimeters ESD values are closer to calculated kerma at the distance of 79.5 cm ESD.
- We can trust X-ray machine readings because given result is higher than obtained and calculated by measuring with TLD dosimeters, this could happen because TLD dosimeters might not collect all radiation.

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