Diagnostic reference levels at intraoral and dental panoramic examinations

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► ***Short Report***

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ABSTRACT

Background: The aim of this study was to measure and determine diagnostic reference levels (DRLs) of programs used at intraoral and dent panoramic examinations in Kosovo. ***Materials and Methods:*** To determine DRL, were performed measurements for dose area product (DAP) at intraoral and dental panoramic radiology systems. This study has covered over 47% of X-ray units, which are in use for intraoral and panoramic imaging examinations on the country. ***Results:*** From results, we conclude that, the mean of DAP (mGy cm^2) for single intraoral examination is 26.8, 29.6 and 39.7 for incisor, premolar and molar, respectively. Therefore the mean of DAP (mGy cm^2) value for panoramic dental radiology is 62.7, 74.1 and 90.3 for child, adult and large adult, respectively. For each modality mention above are proposed specific DRLs. ***Conclusion:*** Recommended DRLs value for intraoral radiography for incisor, premolar and molar programs are: 28.5, 36.5 and 50.3 mGy cm^2, respectively. Also, DRLs for dental panoramic radiography for child, adult and large adult programs are: 73.0, 81.0 and 93.0 mGy cm^2, respectively.
A better quality assurance (QA) and quality control (QC) should be enforcement. For strengthening of QA and QC engagement of radiographers and Medical Physicist is mandatory.

Keywords: *Reference levels, dose area product, intraoral, panoramic, dent.*

INTRODUCTION

Radiographs are essential in today's medicine and especially in dental diagnosis. It is well known that ionizing radiation is used to get radiography of teeth. According to ALARA principle for radiation protection, dentists must expose patients to lowest possible radiation with sufficient quality of imaging. By this principle, also the public and professional exposures will be reduced. It is known that there is no limit for medical exposures, but diagnostic reference levels (DRLSs) for each practice must be respected.

Because of the potential risks of radiation it is necessary to take precautions. Radiation can be considered safe, for patient and public as well as for occupational workers only when specific measures are taken, like as distance from radiation source, shielding, exposure time, orientation of the tube, type of collimator and tube parameters. Attention should be to primary and secondary (scattered) radiation.

The amount of scattered radiation striking the patient's abdomen during a properly conducted radiographic examination is negligible. Radiation exposure arising from dental radiology is considered low; a child may undergo repeated dental radiological procedures throughout childhood and adolescence. Thus, the risks associated with cumulative doses should be taken into consideration [1].The thyroid gland is more susceptible to radiation exposure during dental radiographic exams given its anatomic position, particularly to children [2, 3]. Risk of cancer from radiation in children was more than adult and in female patients is more than male patients in dental X-ray examinations [4].

It is well known that there is not applicable dose limits for medical exposures but principles of justification and optimization of practice must be on consideration [5]. According to new Basic Safety Standard for procedures using medical radiological equipmentmust put in placespecific diagnostic reference levels (DRLs) [6] also DRLs are recommended by the International Commission of Radiological Protection (ICRP) [5]. These are based on the third quartile values for the distributions of doses found in the national or regional surveys.

There are some recommended methods to set DRLs, like measuring of entrance surface dose (ESD), dose area product (DAP) or entrance surface air kerma without backscatter (ESAK) [7] also dose width product (DWP) is used. But the most common used is dose area product (DAP). A DAP meter consisting of a translucent transmission ionization chamber with electrometer, this system is a convenient method to quantify the dose without the presence of patients, also is mobile and easily can be installed on X-ray tube. Usage of a DAP meter allows an easy method to collect the necessary data for standardization practices in general, in particular it can be easy used for dental radiology. Examination without patient presence is advantage of DAP meter.

Dental radiological examinations are among the most common medical exposures [8]. There are two basic techniques: intraoral and dental panoramic radiology [9, 10]. The former involves placing a film inside the mouth and the use of dedicated dental X-ray tube. In dental panoramic radiology both the tube and the film move around head.

This paper is the first attempt in Kosovo to establish DRLs, for investigating intraoral and dental panoramic radiological facilities and do not cover cephalometric practices.

MATERIALS AND METHODS

The data were collected during 2016 on Kosovo territory. On that time at Institute of Occupational Medicine database were registered 68 dental clinics and one dental hospital. Randomly are selected 36 intraoral and 21 panoramic dental radiology units for further analysis.

Measurements of DAP values were conducted by calibrated Diamentor CD-R electrometer produced by PTW, Freiburg GmbH, Germany. Ionizing chamber of DAP meter was attached to exit slit of the X-ray tube. The calibration of DAP to diagnostic X-ray energies was done by the manufacturer for each program. Correction coefficients were used for room temperature and pressure. Multimeter was used also to measure: tube voltage, total filtration, half value layer and irradiation time (PTW Nomex). Film was used to measure field sizes for theintraoral unit and collimator height was used. A questionnaire is prepared to collect technical information of X-ray machines under the study, such as: model, cone type, manufacturer, date of manufacture and type of detectors.

Common statistical parameters have been calculated (such as the mean, standard deviation and 3rd quartile) according to the Radiation Protection Document No. 109 of theEuropean Commission [11]. Minitab and XLSTAT software were used for data calculations.

RESULTS AND DISCUSSION

For each intraoral and panoramic unit under the study was measured DAP at three different programs: incisor, premolar, molar and child, adult, large adult, respectively. Input parameters, mean value of DAP and recommended DRLs for intraoral and dental panoramic units are presented in table 1.

At some dental clinics for intraoral radiography systems are still in use few systems older than 35 years, some of them had mechanical exposure timers and the others hadpointed cones. Those units should get out of service for different reasons, like as beam diameter at the top of pointed cones is around 12 cm and a source-to-skin distance (SSD) is less than 15 cm. So, if use SSD of 40 cm, rather than short distances of 20 cm, decreases exposure by 10 % to 25 % (12, 13). Distances between 20 cm and 40 cm are appropriate, but the longer distances are optimal (14).

Settings of input parameters are important for intraoral and for panoramic dental radiology, because it will have strong impact on patient dose. Those parameters have higher effects on intraoral than on extraoral radiography. So, patient dose in intraoral radiography changed proportionally to the value of mA s, whereas the change depended on mA s to a relatively lesser degree in extraoral radiography (16).

Predominantly primary care locations do not respect enough justification principle. Identified cases are: self-referral cases and high number of examination. Those cases mostly are done by dentist, which have installed an X-ray machine at dentist chair.

Similar results are published by different authors like as Tierris *et al.* (16) and Helmrot *et al.* [10]. At the first research authors measured DAP for 62 panoramic settings: male (101 mGy cm^2), female (85 mGy cm^2) and child (68 mGy cm^2). At second research are presented DAP results of intraoral settings with tube voltage from 60 up to 70 kV they resulted to give DAP values from 0.006 up to 0.033 Gy cm^2 and for panoramic radiography measured DAP values are from 0.035 up to 0.092 Gy cm^2 for tube voltage from 60 up to 74 kV.

Usages of dental portable X-ray machines are increased every day and at some places are missing specialised radiographers/imaging technicians.

Biggest difference between the same programs is identified to intraoral units comparing to panoramic examination.

Table 1. Input parameters, DAP and 3-re quartile of DAP for intraoral and dental panoramic radiography.

Program	Intraoral			Panoramic		
	Incisor	Premolar	Molar	Child	Adult	Large adult
Number of units	32	32	32	21	21	21
Mean tube voltage [kV]	60.1	61.7	63.4	64.3	68.1	72.8
Mean tube current [mA]	6.6	6.4	6.4	11.3	11.4	12.8
Mean exposure time [s]	0.19	0.26	0.29	15.9	15.8	16.2
Mean DAP [mGy cm2]	26.8	29.6	39.7	62.7	74.1	90.3
SD of DAP [mGy cm2]*	16.0	15.55	23.15	29.4	28.9	31.7
3rd quartile value of DAP[mGy cm2]	28.5	36.5	50.3	73.0	81.0	93.0

* SD – standard deviation

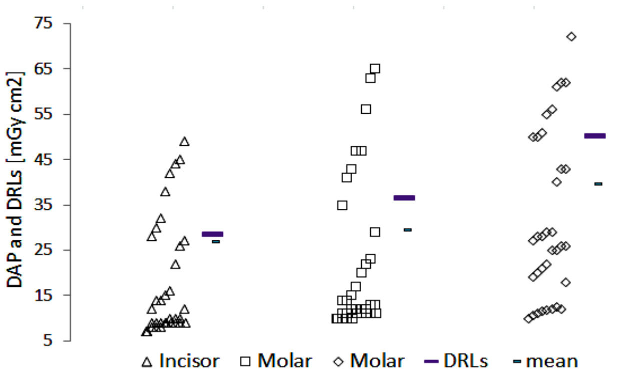

Figure 1. DAP at Dental Intraoral Units.

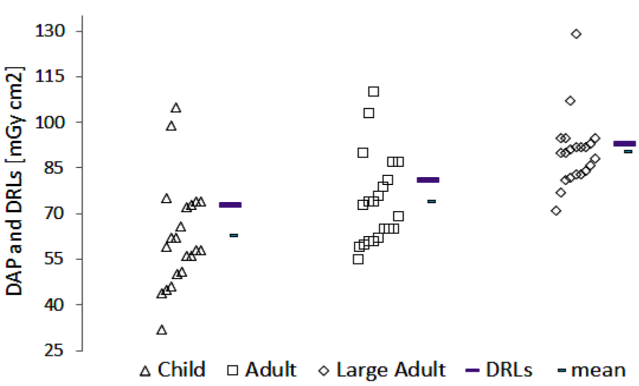

Figure 2. DAP at dental panoramic units.

CONCLUSION

From results, we conclude that the mean of DAP (mGy cm^2) for single intraoral examination is 26.8, 29.6 and 39.7 for incisor, premolar and molar, respectively. Therefore the mean of DAP (mGy cm^2) value for panoramic dental radiology is 62.7, 74.1 and 90.3 for child, adult and large adult, respectively. 3rd quartile are calculated

Recommended DRLs value, for intraoral radiography programs: incisor, premolar and molar are: 28.5, 36.5 and 50.3 mGy cm^2, respectively. Also, DRLs for dental panoramic radiography programs: child, adult and large adult are: 73.0, 81.0 and 93.0 mGy cm^2, respectively.

X-ray units on use with cone collimator and manual timer should be forbidden to be use on the future due to high dose produced by them.

For better quality control a specialized radiographer, imaging technicians and medical physicist must be engaged.

Further studies will be required to establish other diagnostic reference levels in Kosovo, such as lateral cephalometric radiology and dental cone beam computed tomography.

Conflicts of interest: *Declared none.*

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