

## Doses for The Eye Lens and Thyroid in Dental Radiology: Experience in The Municipality of Salvador, Bahia, Brazil



### MEDICAL SCIENCE

KEYWORDS : Dosimetry.Incidence.Dose. Kerma.

**Guillermo Alberto Lopez**

Department of Interactive Processes of Organs and Systems, Institute of Health Sciences, Federal University of Bahia, Salvador, (BA), Brazil

**Paulo Sergio Flores Campos**

Department of Interactive Processes of Organs and Systems, Institute of Health Sciences, Federal University of Bahia, Salvador, (BA), Brazil

### ABSTRACT

*X-rays are electromagnetic waves that have important physical properties, such as: a) the blackening of photographic film; b) the production of secondary or scattered radiation when passing through the body; c) dissemination in a straight line and in all directions; d) the ability to pass through a body that is directly proportional to the tube voltage (kV) in the equipment used; e) obedience to the inverse square law ( $1/r^2$ ); f) inducing genetic mutations by interacting with reproductive cells. The objective of this study was to compare the radiation doses obtained from two types of radiological equipment, both of the Kodak® 2200 Intraoral X-ray System, with similar characteristics used for digital periapical x-rays. Input doses for organs were measured using a skull prototype containing dry bone and material equivalent to human tissue. To measure the input doses, a Radcal® Accu-Gold® radiodiagnostic solid state sensor was used to measure and compare the effective doses displayed on the equipment with what was actually captured in the sensor. Using a 60 kV and 70 kV voltage, the following results were obtained: the mean radiation dose was 0.010 mGy in the lens, and 0.470 mGy in the thyroid. The results were compared with those of other studies using similar protocols and intraoral devices. After analyzing the results, it was concluded that radiation exposure conditions that patients are subjected to in dental radiographic procedures should be observed with great accuracy, as the risk of possible biological effects can be reduced if optimum technical parameters are used.*

### INTRODUCTION

The intensity of a wave is the amount of energy transmitted per every unit of area and time, expressed in  $W/m^2$ . In the case of electromagnetic radiation present in floating bodies, part of its intensity can be reflected at the air-skin interface, while the other part can be transmitted to the human body. [1]

X-rays are electromagnetic waves that have important physical properties, such as: a) the blackening of photographic film; b) the production of secondary or scattered radiation when passing through the body; c) dissemination in a straight line and in all directions; d) the ability to pass through a body that is directly proportional to the tube voltage (kV) in the equipment used; e) obedience to the inverse square law ( $1/r^2$ ); f) inducing genetic mutations by interacting with reproductive cells. [2]

The soft tissues can alter the absorption of radiation, increase dispersion, influence the film contrast and density and consequently affect diagnostic precision. [3]

The concept of risk aims to quantify the possible harmful effects of exposure. The role of dosimetry is to determine the amount of radiation, that is, the dose an individual receives during a radiological examination. [4]

Measuring radiation doses in organs and tissues is essential in estimating the relative risk of cancer associated with radiation induction. [5]

There is an increased risk of thyroid cancer derived from follicular epithelium after exposure to radiation. Women and children are more susceptible to this kind of cancer, and it is important to note that it is precisely during childhood that orthodontic treatment is most sought after. [6]

Eyes may also be affected by ionizing radiation. The International Commission on Radiological Protection (ICRP), in evaluating recent epidemiological evidence, published a statement on tissue reactions in April 2011 suggesting the eye lens, one of the most radiosensitive tissues of the human body, should have a dose absorption threshold below 0.5 Gy instead of the 2 Gy established standard for cataractogenesis. Based on this new threshold, the ICRP recommended a dose constraint equivalent

to the eye lens of 20 mSv (mean range during determined five year periods), a considerable reduction from the previous 150 mSv dose constraint. Despite recognizing the need to improve eye lens dosimetry, there has been much commentary on the practical implications of this new limit. [7]

### MATERIAL AND METHODS

We created simulated periapical lesions in incisors and compared two types of Kodak® 2200 Intraoral X-ray system digital periapical radiographic equipment with similar features. We used a skull prototype containing dry bone and the equivalent of human tissue with paraffin materials (FIGURE 1). The author of this study acquired equipment measurements between July and December 2013.

The measurement tests with the prototype were performed at a dental clinic in Salvador and one in Lauro de Freitas.

To measure organ input doses—eye lens and thyroid— (FIGURE 2), we used a Radcal® Accu-Gold® solid state sensor for radiology, and a Radcal® Accu-Gold® ionization chamber to measure the effective doses and compare them to the dosage indicated on the equipment. (FIGURE 3)



**Figure 1** Head and neck prototype with real bone and similar tissue.



Figure 2 - Head and neck prototype with the sensor and ionization chamber for eye lens and thyroids

The radiological techniques applied were standard for adult patients, using a 60 kV kilovoltage and 70 kV in digital format.

A positioner was used to set the sensor in place on the imaging plate or X-ray film and to measure the doses.

The results were used for comparisons and to establish correlations and differences between both types of equipment.



Figure 3 - Radcal Accu-Gold solid state sensor and ionization chamber

**RESULTS**

The simulated periapical lesions for the first incisor of the upper jaw and the first incisor on the right side of the lower jaw generated following results:

For parotid glands, being bilateral organs, there was an average of radiation doses from both sides in all tests. The results are presented below in the form of tables and graphs.

Table 1 - Upper incisor: voltage, current, time, dose and filtration to different organs in equipment 1

Filteration (mm)	2,52	3,06	2,52	3,06
mAs	4,7	2,3	4,7	2,3
Dose in the digital image receptor CR (mGy)	0,363	0,336	0,411	0,370
Time measured (msec)	679	340	680	340
Organ dose (mGy)	0,016	0,014	0,060	0,036
measured kV	62,8	76,3	62,5	76
Time (msec)	580	290	580	290
mA	7	7	7	7
Nominal kV	60	70	60	70
Organ	Eye Lens		Thyroid	

Table 3 - Upper incisor: voltage, current, time, dose and filtration to different organs in equipment 2

Filteration (mm)	2,21	2,64	2,21	2,64
mAs	4,7	2,3	4,7	2,3
Dose in the digital image receptor CR (mGy)	0,404	0,336	0,389	0,327
Time measured (msec)	678	340	676	339
Organ dose (mGy)	0,0035	0,0048	0,0065	0,0054
measured kV	63,3	73,9	62,8	73,7
Time (msec)	680	340	680	340
mA	7	7	7	7
Nominal kV	60	70	60	70
Organ	Eye Lens		Thyroid	

Table 4 - Lower incisor: voltage, current, time, dose and filtration to different organs in equipment 2

Filteration (mm)	2,42	2,64	2,42	2,64
mAs	4,7	2,3	4,7	2,3
Dose in the digital image receptor CR (mGy)	0,39	0,33	0,39	0,35
Time measured (msec)	679	343	695	362
Organ dose (mGy)	0,0033	0,0052	0,0088	0,0067
measured kV	62,5	74,2	61,9	75,7
Time (msec)	680	340	680	340
mA	7	7	7	7
Nominal kV	60	70	60	70
Organ	Eye Lens		Thyroid	

**DISCUSSION**

In relation to the upper incisor, the incidences with 60 kV and 70 kV voltage and different exposure times (equipment 1: 580 and 290 msec; equipment 2: 680 and 340 msec), had a higher dose increment of radiation in the eye lens (0.016 mGy and 0.014 mGy) compared with equipment 2 (0.0035 mGy and 0.0048 mGy). In the thyroid doses (0.036 mGy and 0.060mGy) obtained with equipment 1, doses were higher than those obtained from equipment 2 (0.0065mGy and 0.0054 mGy,

respectively). It should be noted that these two devices not only have the same characteristics, but a positioner was also used to insert the sensor in place on the match plate to take dose measurements, despite a discrepancy showing up between the absorbed doses.

When x-rays of the lower incisor were taken with a 60 kV and 70 kV voltage, the equipment behaved similarly with the upper incisor x-rays with the same voltage. With the eye lens, the highest doses were obtained from equipment 1 (0.014 mGy and 0.010mGy) with a 60 kV and 70 kV voltage respectively. With the thyroid dose at 60 kV and 70 kV, highest doses were depicted in equipment 1 (0.106 mGy and 0.087 mGy). Radiology reference levels for periapical x-rays were established by Federal Decree No. 453 of the Health Surveillance Secretariat on June 1st, 1998, and indicated values up to 3.5 mGy as acceptable for skin entrance doses (DEP).

Comparing the average between the values obtained from this work for the radiation dose in the head and neck, with those contained in three studies that reference protocols between 60 kV and 80 kV, current intensities applied to the tube between 6 mAs and 10 mAs and exposure times between 120 msec and 180 msec (LOPEZ, 2013), it appears that in the present study, the average is lower in the eye lens (0.010 mGy) and is in the highest position in relation to the thyroid (0.470 mGy), pointed out in Table 5.

**Table 5 - radiation dose in head and neck organs: comparison between results of four studies.**

Author	Lens	Thyroid
Endo et al.(2012)	0,028	0,354
Ludlow et al. (2003)*	0,020	0,050
Gavalaet a l.(2009)*	0,055	0,088
López (2013)	0,010	0,470

Note: \* Apud Endo and colleagues (2012, p.216)

The radiation exposure conditions that patients are subjected to in dental radiographic procedures should be observed with great accuracy, as the risk of possible biological effects can be reduced if optimized technical parameters are used.

### CONCLUSIONS

Given the results obtained and analyzed, we highlight the importance of using low radiation doses and properly positioning the equipment to generate radiographic views for periapical examinations in the maxillary and mandibular region because if the beam is not in the exact position indicated, there may be a radiation dose increase in organs near the examined region. As a result, an optimum radiological examination can be obtained, resulting in an image of diagnostic quality and low radiation doses that minimize biological effects on radiosensitive structures in the head and neck region. The radiation exposure conditions to which patients are subjected to in dental radiographic procedures should be observed with great accuracy, since the risk of possible biological effects can be reduced if optimal technical parameters are used.

## REFERENCE

- [1]Okuno, Emico; Yoshimura, Elisabeth.(2010) Física das radiações. São Paulo: Oficina de Textos, | [2]ICRPInternational Commission on Radiological Protection. (2007) The 2007 recommendations of the International Commission on Radiological Protection.Publication 103. Oxford: Pergamon Press | [3]SCHROPP, L. et al.( 2012) Validity of wax and acrylic as soft-tissue simulation materials used in in vitro radiographic studies. Dentomaxillofacial Radiology, London, v. 41, p. 686-690 | [4] MEGHZIFENE, A. et al. (2010) Dosimetry in diagnostic radiology. European Journal of Radiology, Limerick, v. 76, p. 24-27. | [5] ENDO, A. et al. (2012). Characterization of optically stimulated luminescence dosimeters to measure organ doses in diagnostic radiology.DentomaxillofacialRadiology, London, v. 41, n. 3, p. 211-216. | [6] SANSARE, K. P. et al. (2011). Utility of thyroid collars in cephalometricradiography.Dentomaxillofacial Radiology, London, v. 40, p.471-475. | [7] O'CONNOR, U. et al. (2013).Occupational radiation dose to eyes from endoscopic retrograde Cholangiopancreatography procedures in light of the revised eye lens dose limit from the International Commission on Radiological Protection.British Journal of Radiology, London, v. 86, p.1-9.