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Salivary gland entrance dose in dental radiology

Doses de entrada em glândulas salivares na radiologia odontológica

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Resumo
Introdução: Os tecidos moles alteram a absorção de radiação e aumentam a dispersão, e podem influenciar o contraste e a densidade do filme e, em consequência, a precisão do diagnóstico. A medida da dose de radiação sobre órgãos e tecidos é essencial para a estimativa do risco relativo de câncer associado à indução por radiação. **Objetivo**: avaliar dose de entrada em glândulas salivares, com dois equipamentos digitais em um fantoma de cabeça e pescoço. **Metodologia**: Realizou-se a simulação de incidências periapicais de dentes incisivos, comparando-se dois equipamentos radiológicos periapicais digitais da marca Kodak® 2200 Intraoral X-ray System de características similares. Utilizou-se um protótipo de crânio contendo osso seco e material equivalente a tecido humano com parafina. Para a medição das doses de entrada em órgão: glândulas parótidas e glândula sublingual utilizou-se um sensor de estado sólido marca Radcal® Accu-Gold® para radiodiagnóstico e uma câmara de ionização marca Radcal® Accu-Gold®, onde foram medidas as doses efetivas e comparadas as indicadas no equipamento com as capturadas no sensor. **Resultados**: em glândulas parótidas foram 0,033 mSv e 0.388 mSv em sublingual. **Conclusão**: Dos resultados obtidos e analisados, destaca-se a importância da utilização de doses baixas de radiação e do adequado posicionamento do equipamento para realizar as incidências radiológicas de exames periapicais em região maxilar e mandibular, uma vez que, não estando o feixe na posição exata indicada para essas incidências, pode ocorrer um aumento de dose de radiação nos órgãos próximos à região estudada.
Palavras-chave: Radiografia dentária. Dosagem de radiação. Glândulas salivares.

Abstract
Introduction: *Soft tissues modify radiation absorption and increase dispersion. It can also influence the density and the contrast of the film, and therefore, the diagnosis accuracy. In order to estimate the relative risk of cancer associated with induction by radiation, it is important to measure radiation doses at organs and tissues.* ***Objective:*** *to evaluate salivary glands entrance dose, with two digital devices in a head and neck phantom.* ***Methodology:*** *Periapical incidences simulations of incisors were conducted and compared with two digital periapical radiological equipment (Kodak® 2200 Intraoral X-ray System) which have similar characteristics. A dry bone skull prototype and an equivalent human tissue material with wax were used. To measure the organ entrance dose: parotid gland and sublingual glands, it was used a solid-state sensor from Radcal®, Accu-Gold® for diagnostic radiology and an ionization chamber from Radcal®, Accu-Gold®, where effective doses were measured in the equipment and in the sensor and then compared.* ***Results:*** *in parotid glands were 0.033 mSv and in sublingual 0.388 mSv.* ***Conclusion:*** *It is important to highlight from the results the importance of using low doses of radiation and the appropriate equipment positioning in order to perform periapical radiological incidences in maxillary and mandibular regions. If the beam it is not corrected positioned, an increase in the radiation dose to organs can occur near to the area of study.*
Keywords*: Radiography, dental. Radiation dosage. Salivary glands.*

INTRODUCTION

A wave intensity is the disseminated amount of energy per unit of area and time, expressed in W/m^2. Considering incident electromagnetic radiation in the air, part of its intensity can be reflected at the air-skin interface, and part can be transmitted to the human body (OKUNO; YOSHIMURA, 2010).

X rays are electromagnetic waves that have important physical properties such as: a) black photographic film; b) produce secondary or scattered radiation when cross a body; c) propagate in a straight line and in all directions; d) its ability to cross a body is directly proportional to the equipment voltage (kV); e) follow the inverse-square law (1 / r 2); f) can cause genetic mutations when interact with reproductive cells (ICPR, 2007).

Soft tissues modify radiation absorption and increase dispersion. It can also influence the density and the contrast of the film, and therefore, the diagnosis accuracy (SCHROPP et al., 2012).

The concept of risk aims to quantify the possible harmful effects of exposure. The role of dosimetry is to define the radiation amount, that is, the dose received by an individual during a radiological examination (MEGHZIFENE et al., 2010).

In order to estimate the relative risk of cancer associated with induction by radiation it is important to measure the radiation doses at organs and tissues (ENDO et al., 2012).

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There is an increased risk of thyroid cancer derived from follicular epithelium after radiation exposure. Women and children are more susceptible to this type of cancer, and it is relevant to say that it is precisely in childhood that orthodontic treatment is most wanted (SANSARE et al., 2011).

Eyes cal also be affected by ionizing radiation. The International Commission on Radiological Protection (ICRP), assessing recent epidemiological evidence, published in April 2011, a statement on tissue reactions, suggesting that for the lens of the eye, one of the most radiosensitive tissues of the human body, the dose absorbed threshold for cataractogenesis should be considered below 0.5 Gy, instead of 2 Gy that was previously established. Based on this new threshold, ICRP recommended a limit on equivalent dose for the lens of the eye of 20 mSv (with average defined in periods of 5 years), a considerable reduction from the previous limit on equivalent dose of 150 mSv. Although the need of improvement in the lens dosimetry has been recognized, a lot has been discussed about the practical implications of this new limit (O'CONNOR et al., 2013).

A very significant change for dental radiology is the inclusion of the salivary glands. As it is a radiosensitive tissue, high radiation dose can lead to decreased production of saliva (MORANT et al., 2013).

OBJECTIVE

Evaluate the skin entrance dose in salivary glands of a head and neck phantom.

METHODOLOGY

Periapical incidences simulations of incisors were conducted and compared with two digital periapical radiological equipments (Kodak® 2200 Intraoral X-ray System) which have similar characteristics. A dry bone skull prototype and an equivalent human tissue material with wax was used (Figure 1). The image acquisitions were taken with the assistance of a film holder, in which the sensor was fixed (Figure 2).

Figure 1 – *Head and neck prototype containing real bones and equivalent tissue*

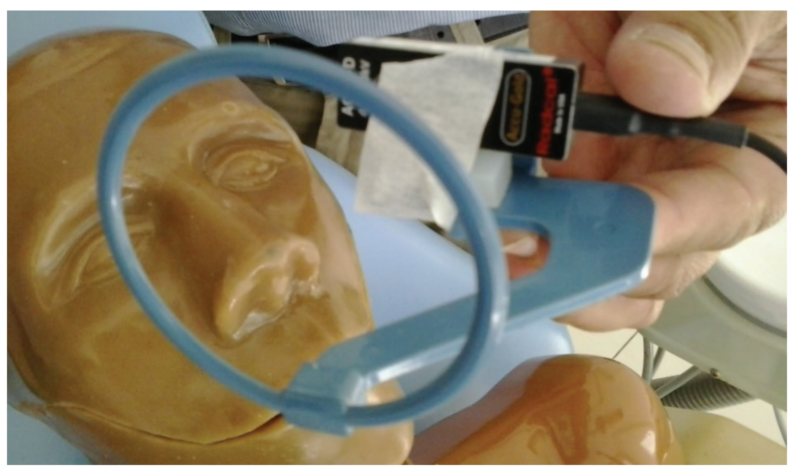


Figure 2 – *Film holder with the sensor fixed to it*

To measure the organ entrance dose – parotid glands and sublingual glands – a solid state sensor from Radcal® Accu-Gold® for diagnostic radiology and an ionization chamber Radcal® Accu-Gold® were used (Figure 3), where effective doses were measured in the equipment and in the sensor and then compared.

Radiological techniques applied were those provided for standard adult patients with 60 kV and 70 kV in digital format. Thus, periapical incidences were simulated for the first incisor of the upper jaw and the first incisor of the lower jaw on the right side.

Comparisons were made using the results as well as the establishment of correlations and differences between the two equipments evaluated.

Figure 3 – *Head and neck prototype with sensor and ionization chamber in the sublingual gland*

RESULTS

For the parotid glands, that are bilaterals, an average on radiation dose on both sides was taken in all tests. The results are presented below in tables and graphs.

Table 1 – Upper incisor: voltage, current, time, dose and filtration for different organs in the first equipment

Organs	kV nominal	mA	Time (mseg)	kV measured	Organ dose (mGy)	Time measured (mseg)	Dose at the digital image receptor CR (mGy)	mAs	Filtration (mm)
Parotid	60	7	580	62,6	0,130	680	0,371	4,7	2,52
	70	7	290	76	0,119	339	0,341	2,3	3,06
Sublingual	60	7	580	62,5	0,003	680	0,375	4,7	2,52
	70	7	290	75,9	0,003	340	0,344	2,4	3,06

Table 2 – Lower incisor: voltage, current, time, dose and filtration for different organs in the first equipment

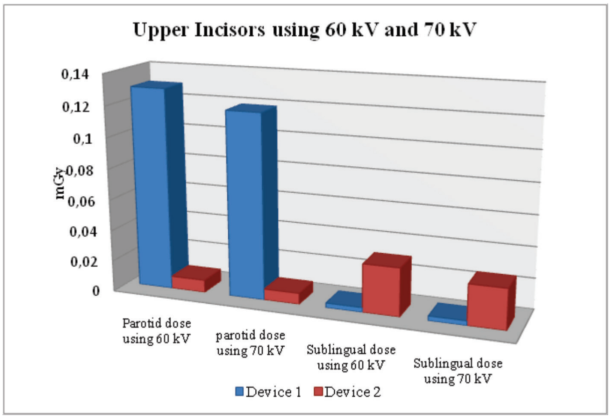
Organs	kV nominal	mA	Time (mseg)	kV measured	Organ dose (mGy)	Time measured (mseg)	Dose at the digital image receptor CR (mGy)	mAs	Filtration (mm)
Parotid	60	7	580	61,5	0,128	696	0,375	4,8	2,53
	70	7	290	72,5	0,117	359	0,346	2,5	3,07
Sublingual	60	7	580	62,5	0,057	690	0,398	4,8	2,53
	70	7	290	73,7	0,038	363	0,364	2,5	3,07

Table 3 – Upper incisor: voltage, current, time, dose and filtration for different organs in the second equipment

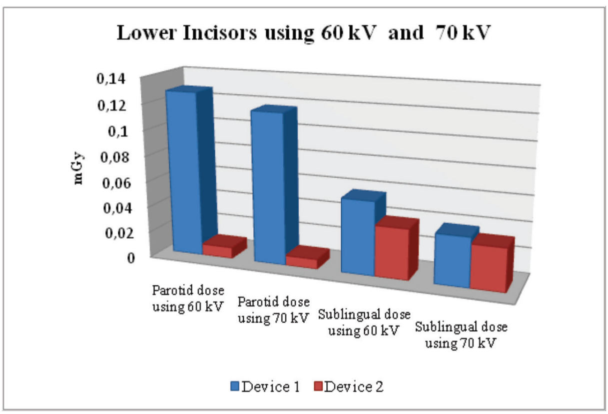
Organs	kV nominal	mA	Time (mseg)	kV measured	Organ dose (mGy)	Time measured (mseg)	Dose at the digital image receptor CR (mGy)	mAs	Filtration (mm)
Parotid	60	7	680	63,0	0,0080	677	0,400	4,7	2,21
	70	7	340	73,9	0,0071	339	0,334	2,3	2,64
Sublingual	60	7	680	62,9	0,031	677	0,392	4,7	2,21
	70	7	340	73,6	0,026	338	0,327	2,3	2,64

Table 4 – Lower incisor: voltage, current, time, dose and filtration for different organs in the second equipment

Organs	kV nominal	mA	Time (mseg)	kV measured	Organ dose (mGy)	Time measured (mseg)	Dose at the digital image receptor CR (mGy)	mAs	Filtration (mm)
Parotid	60	7	680	62,8	0,0086	691	0,39	4,7	2,42
	70	7	340	75,6	0,0075	347	0,33	2,3	2,64
Sublingual	60	7	680	64,5	0,039	687	0,45	4,7	2,42
	70	7	340	74,6	0,033	356	0,35	2,3	2,64



Graph 1 – *Organ doses with incidences on upper incisors on both devices with voltages of 60 kV and 70 kV*



Graph 2 – *Organ doses with incidences on lower incisors on both devices with voltages of 60 kV and 70 kV*

DISCUSSION

For the upper incisor, the 60 kV and 70 kV incidences, exposure times (equipment 1: 580 msec and 290 msec; equipment 2: 680 msec and 340 msec), a higher incremental dose radiation on parotid glands (0.130 mGy and 0.119 mGy) compared to the equipment 2 was noticed. For sublingual gland, doses (0.003 mGy and 0.003 mGy) obtained with equipment 1 were lower than those obtained with equipment 2 (0.031 mGy and 0.026 mGy, respectively).

It is important to mention that both equipments have the same characteristics. A positioner was used to insert the sensor in the phosphor's plate position when performing the measurements. Therefore, differences between absorbed doses were noticed.

After performing incidences of the lower incisor with 60 kV and 70 kV, both equipments behaved similarly with upper incisor incidences using the same voltages. For the parotid, the highest doses were obtained with equipment 1 (0.128 mGy and 0.117 mGy with 60 kV and 70 kV, respectively). For sublingual gland, using 60 kV and 70 kV, higher doses were recorded for equipment 2. Reference levels for diagnostic radiology of periapical incidences were established by Portaria Federal No. 453 of Secretaria de Vigilância Sanitária on June 1st 1998, which indicated as acceptable values up to 3.5 mGy for entrance skin dose (ESD).

The average doses obtained in this work for the radiation dose in organs of the head and neck were compared to three studies that follow protocols with voltages between 60 kV and 80 kV, current between 6 mAs and 10 mAs and exposure times between 120 msec and 180 msec (ENDO et al., 2012). It is noticeable that the average for parotid glands is lower (0.033 x 0.510, 0.740, 0.795) and it remains in the middle position for sublingual (0.388 x 0.119, 0.023 and 0.540). This is explained on Table 5.

Table 5 – *Radiation doses for organs of the head and neck: comparison among four studies*

Author	*Parotids*	*Sublingual*
Endo et al.(2012)	0,795	0,119
Ludlow et al. (2003)*	0,740	0,540
Gavala et al.(2009)*	0,510	0,023
López (2013)	0,033	0,388

Source: Author's adjustment.

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

Since the risks of possible biological effects can be reduced using optimized technical parameters, it is clear that the radiation exposure which patients undergo in dental radiology must be watched with great accuracy.

CONCLUSION

It is important to highlight from the results the importance of using low doses of radiation and the appropriate equipment positioning in order to perform periapical radiological incidences in maxillary and mandibular regions. If the beam it is not corrected positioned, an increase in the radiation dose to organs can occur near to the area of study. As a result, an optimization of the radiological examination may be obtained, resulting in an image with diagnostic quality and low radiation doses that minimize biological effects on radiosensitive structures of the head and neck.

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