DOSIMETRIC EVALUATION PROGRAM FOR DENTAL RADIOLOGY PRACTICES

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ABSTRACT

The preliminary results of a program undertaken to estimate the doses to patients associated with dental radiology practices in Argentine, are presented.

Information collected from the search demonstrated that the Dieck and coronal technics are the most commonly used practices,while all the examinations are performed by using a circular collimator.For both practices, the dosimetric studies were carried out on a Rando Alderson phantom. All dose measurements were made using thermoluminiscent detectors LiF and CaF_2. In addition, a mathematical model was developed by applying the Monte Carlo method to a MIRD-V phantom. Circular and rectangular collimators were used.

Absorbed dose distribution on head and neck, as well as surface dose distribution, were estimated. The comparison of the performance of both collimators shows that the use of the rectangular one allows for a dose reduction of 80%. Besides, a good correlation between the physical and mathematical models applied was found.

INTRODUCTION

The preliminary results of a program undertaken to estimate the doses to patients associated with dental radiology practices in Argentina are presented. This program includes the following steps:

-a) a statewide survey was carried out on unidentified professionals involved in dental radiology in order to obtain information on the radiology techniques applied, irradiation conditions, number of examinations, etc.;
-b) dosimetric assessments concerning dental radiology practices;
-c) analysis of the working sites;
-d) recommendations on optimization of radiology practices.

Over a total of 1200 dentist resident at La Plata city,there were 300 of them surveyed. The survey showed the following results:

-The techniques most frequently used are: Dieck (41.8%); four film interproximal (coronal) (24.1%); oclusal (16.5%); Fitzgerald (10.7%); extraoral (7%). In all cases, circular collimation was used.
-Film type : 3 x 4 cm^2 (35.2%)
-Operation voltage: 60 kVp (32.3%), 65 kVp (29.8%)
-Operation current: 10 mA (67.7%)
-Exposure time : from 0.1 s to 1 s (76.5%)

-Image analysis : visual (100%)

Up today, dosimetric data was attained regarding both Dieck and coronal techniques. For the former, the assessed practice consisted in 14 consecutive exposures of the upper maxilar and the mandible, while for the latter, 4 exposures of premolar and molar teeeth were performed.

DOSIMETRIC ASSESSMENT

The dosimetric assessment was carried out by using a physical model based upon an equivalent tissue phantom RANDO (Alderson) and LiF and Ca_2F thermoluminiscent detectors. By distributing them in the inner parts and on the surface of the head, the neck and the trunk, absorbed doses in organs and tissues were evaluated.

Two types of collimators were used, a circular one (CC) and a rectangular one (RC). The performance of the latter was assessed.

The irradiations were made by using an OSO X-ray unit, with an operation voltage and a current of 60 kVp and 10 mA, respectively. Both collimators, 7 cm diameter window CC, and 3 x 4 cm^2 window RC, were used with a 15 cm focus-skin distance.

Tables 1 and 2 show the corresponding results. Mean absorbed doses exceeding 5 10^{-2} mGy are presented. Figures 1 and 2 show the distribution of the mean superficial doses in the head and in the neck.

An overall error of 20% may be assigned to the expressed results . The main contributions to this error may be described as follows: a) Use of a mean mass attenuation coefficient, not fully reperesentative of the energy distribution inside the phantom; b) Errors in the assigned mass fraction of an organ in the phantom slabs.

As an alternative, a mathematical model based upon the application of the Monte Carlo method to the photon transport in the MIRD-V phantom was used [1]. In order to improve the dosimetric evaluation in the head and the neck, the MIRD-V phantom was modified by including an upper maxilar, a mandible and parotid, sublingual and submaxilar glands. The X-ray spectra at the output of each collimator was simulated, as well as the shadow of the incident beam on the phantom surface.

The results corresponding to Dieck´s technique are shown in Table 3. Only absorbed doses with a variation coefficient less than 5% are presented.

CONCLUSIONS

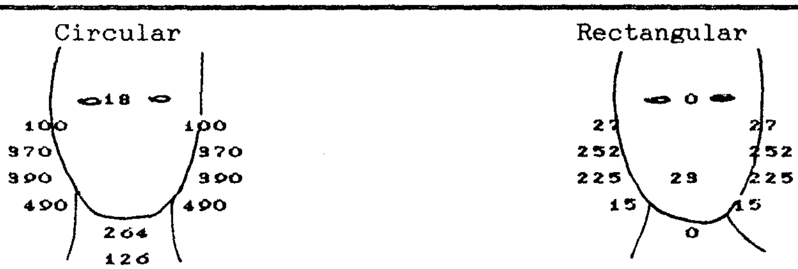
The evaluation of the information recalled from the professionals showed that the working conditions are satisfactory enough as to allow the obtention of the necessary image quality for a proper diagnosis.

Dosimetric data demonstrate that the use of a RC implies a reduction of the absorbed dose in the lens of two orders of magnitude, and, as a mean, a five fold dose reduction for the other organs. This significative dose reduction may be explained by the lessening of the exposure area, without diminishing the diagnosis quality. Absorbed doses in trunk organs are not significant.

Results obtained with the two models do not differ more than 15%, for those organs described in a similar way in both phantoms, while the difference increases to 30% for sublingual and submaxilar glands, which are not easily localized in the RANDO phantom. The above mentioned results justifies the use of the mathematical model in future dosimetric assessments.

Figure 1 : Dieck's Technique
Distribution of the mean superficial dose (10^{-2} mGy)

Figure 2 : Coronal Technique
Distribution of the mean superficial doses (10^{-2} mGy)



REFERENCES

1-Spano,F.; Thomasz, E.; Modelo de exposición en campos externos de radiación. Primer Congreso de la Sociedad Argentina de Radioprotección, Buenos Aires, 1983.

Table 1
Physical model
Absorbed doses distributions in Dieck's Technique
(10^{-2} mGy)

organ	Circular	Rectangular
RBM skull	*	*
RBM mandible	30.8	*
parotid glands	604.	142.
sublingual glands	540.	78.
submaxilar glands	41.	*
head skin (mean)	1214.	324.
lens of the eyes	865.5	7.
thyroid	51.	*
brain	8.	*

note: * less than $5. \times 10^{-2}$ mGy

Table 2
Physical model
Absorbed doses distributions in coronal's Technique
(10^{-2} mGy)

organ	C. Circular	Rectangular
RBM skull	*	*
RBM mandible	*	*
parotid glands	260.	213.
sublingual glands	60.	24.
submaxilar glands	80.	21.
head skin		239.
lens of the eyes	18.	*
thyroid	41.	9.
brain	*	*

note: * less than $5. \times 10^{-2}$ mGy

Table 3
mathematic model
Absorbed doses distributions in Dieck's Technique
(10^{-2} mGy)

organ	Circular	Rectangular
RBM skull	4.	.15
RBM mandible	35.	2.
parotid glands	630.	123.
sublingual glands	415.	*
submaxilar glands	33.	*
head skin (mean)	1100.	351.
lens of the eyes	832.	*
thyroid	61.	4.
brain	8.	.13

note: * variation coefficient great than 5 %