ORGAN DOSES IN ORAL RADIOLOGY

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Using the MIRD 5 phanthom modified by Kramer et al.(Ka82) and the Monte Carlo technique (Sn69), organ doses in patients undergoing external dental examinations were calculated taken into account the different beam geometries and the various incidences of the central beam with regard to the head of the patient. It was necessary to introduce in the original computer program a new source description, specific to dental examinations. To have a realistic evaluation of organ doses during dental examinations,it was necessary to introduce new regions in the phantom head which characterize the jaw (mandible and maxilla) with the teeth and the parotid, submaxillary and sublingual glands.

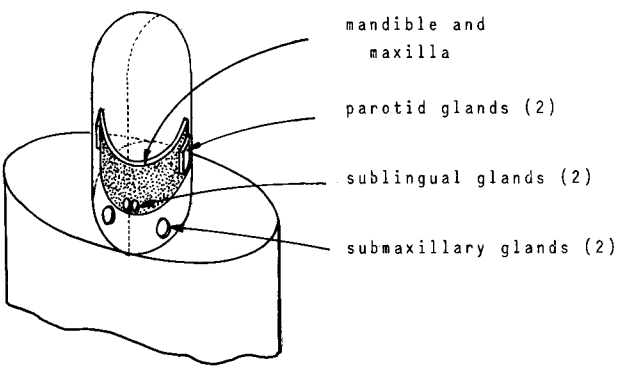

Fig. 1 . Head section of phantom illustrating approximate location of salivary glands and mandible.

Dose calculations were performed for 105 regions in the phantom. The X-rays beam was simulated by typical spectra generated at 50 kV and 70 kV and filtered by 2 mm of aluminium equivalent total filtration. Three regions of the jaw were taken as representative of routine dental examinations: incisor, cuspid and molar regions; and for each one, two incidences were simulated: superior and inferior. Also, three typical focus-skin distances of dental X-rays units were chosen: 10, 18 and 24 cm. Field sizes simulated in the calculations

have diameters of 7.0 , 9.0 and 11.0 cm.

Thirty six tables of organ doses normalized to the exposure at the skin entrance were generated according to the variation of the parameters mentioned above. As examples of the obtained results, tables 1 and 2 show figures of organ doses in typical irradiation geometries in dental examinations.

Table 1. Organ doses in dental examinations for variable incidence.

High Tension: 70 kV
Total Filtration: 2 mm Al
Ø Field at Skin: 7 cm
Focus-Skin Distance: 10 cm

Organ or Tissue	Dose Equiv./Exp. Skin Ent.(rem/R)*					
	Incisor		Cuspid		Molar	
	Inf.	Sup.	Inf.	Sup.	Inf.	Sup.
Thyroid	0.612	-	0.351	0.016	0.079	0.038
Red Marrow						
Facial Skeleton	0.031	0.010	0.039	0.019	0.058	0.059
Head	0.011	0.022	0.016	0.023	0.024	0.029
Total Body	0.002	0.003	0.002	0.003	0.004	0.004
Bone Surface						
Facial Skeleton	0.138	0.040	0.180	0.083	0.259	0.266
Head	0.010	0.127	0.014	0.113	0.023	0.062
Total Body	0.010	0.013	0.011	0.013	0.016	0.018
Skin						
Head	0.040	0.028	0.045	0.034	0.042	0.040
Total Body	0.004	0.003	0.005	0.003	0.004	0.004
Sublingual Glands	0.147	0.012	0.159	-	0.202	0.114
Submaxillary Glands	0.052	-	0.212	-	0.394	-
Parotid Glands	-	-	0.212	0.028	0.394	0.287
Lens of the Eyes	-	0.091	-	0.083	-	-

* - coeff. of variation: less than 10%

Table 2. Organ doses in dental examinations for variable focus-skin distance.

High Tension: 70 kV
Total Filtration: 2 mm Al
Ø Field at Skin: 7 cm
Incidence: Inferior Incisor

Organ of Tissue	Dose Equiv./Exp. Skin Ent.(rem/R)* Focus-Skin Distance (cm)		
	10.0	18.0	24.0
Thyroid	0.612	0.580	0.593
Red Marrow			
Facial Skeleton	0.031	0.033	0.033
Head	0.011	0.012	0.012
Total Body	0.002	0.002	0.002
Bone Surface			
Facial Skeleton	0.138	0.149	0.149
Head	0.010	0.010	0.010
Total Body	0.010	0.010	0.010
Skin			
Head	0.040	0.048	0.043
Total Body	0.004	0.005	0.005
Sublingual Glands	0.147	0.205	0.216
Submaxillary Glands	0.052	0.051	0.052
Parotid Glands	-	-	-
Lens of the Eyes	-	-	-

* - coeff. of variation: less than 10%

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CONCLUSIONS

Tables 1 and 2 present organ and tissues, where large amount of energy were deposited. In other phantom organs and regions not mentioned in the tables, the calculated values were extremely low. It can be observed that significant figures are found for the head and neck regions.

Figures presented in table 1 show the variation of organ doses per unit exposure at skin entrance for 3 representative regions of the jaw and 2 different incidences. From this table it can be seen large variations of thyroid and salivary glands doses with respect either to the region examinated or to the incidence of the central X-rays beam (upper and lower teeth).In table 2, figures are presented for different focus-skin distances. In this table it is shown that organ doses are independent of the focus-skin distances used in the dental units. Some additional tables were generated when the X-rays tube kilovoltage and the field size were modified. As expected, the higher were the field size and the kilovoltage,the higher were the organ doses obtained in the calculations.

In regard to the tissues localized in every part of the human body, namely: red marrow, bone surface and skin, both tables present figures for dose calculations taking into account either regions of the body or the total body. It can be observed that bone marrow and bone surface doses calculated only for the facial skeleton are in average ten times greater than those calculated for the total body. Skin dose is also significantly higher when dose calculations were performed using the head skin mass instead of the total body skin mass.

The results of the calculated organ doses clearly express the dependence on the irradiation geometry and the radiation energy. Therefore, when calculating collective effective dose equivalent for oral diagnostic radiology, organ doses should be weighted for all geometries, the weighting factors being the relative frequencies of dental examinations.

BIBLIOGRAPHY

Ka82 . Kramer,R.; Zankl,M; Williams,G. ans Drexler,G. : " The calculation of dose from external exposures using reference human phantoms and the Monte Carlo method".GSF Bericht S-885 (1982).

Sn69 . Snyder,W.S.; Ford,M.R.; Warner, G. G. and Fisher, H.L.: Journal of Nuclear Medicine,Supplement Number 3,Pamphlet 5, Society of Nuclear Medicine (1969).