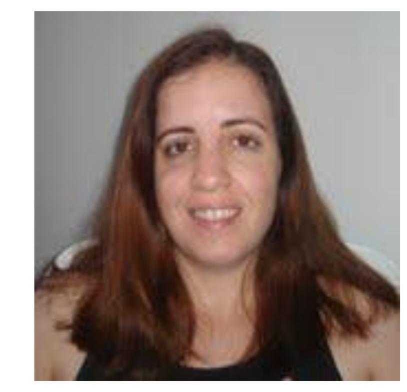
Use of CT Dosimetry Spreadsheet for estimating the effective dose in dental cone beam CT



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1- INTRODUCTION

The Cone Beam Computed Tomography, CBCT, appears in dental radiology as a revolutionary technique and has established itself as a radiological imaging modality that has advantages, in terms of visualization of structures, compared with intra-oral radiography and panoramic radiography [1]. The CBCT technique is currently considered as a tomographic technique of low-dose radiation when confronted with conventional tomography applied to dentistry. The objective of this study was to evaluate the effective dose values for CBCT acquisition of different protocols using the database of the NRPB SR250.

2 - MATERIALS AND METHODS

We evaluated four CBCT equipment, manufactured by Images Sciences i-CAT inc. model Classical i-CAT. Those equipment operate only with tube voltage of 120 kV, pulsed beam and tube current in the range 3-7 mA, according to the manufacturer's technical specifications. The image receptor is amorphous silicon flat panel, a-Si. In the evaluation of effective dose in three-dimensional acquisitions, we use the CT Dosimetry Spreadsheet, version 1.0.2, created by British group IMPACT and the database NRPB-SR250 [3]. To use the spreadsheet CTDosimetry with equipment not available in the data set is necessary to obtain a matching factor called by the authors of the worksheet Impact Factor [2]. Equations 1 and 2.

$$ImpaCT\ Factor = a \times \frac{C_{PMMA,100,center}}{C_{air,100}} + b \times \frac{C_{PMMA,periphery}}{C_{air,100}} + c \qquad (1)$$

$$ImpaCT\ Factor = a \times \frac{\bar{D}_{PMMA\,center}}{\bar{D}_{air}} + b \times \frac{\bar{D}_{PMMA\,periphery}}{\bar{D}_{air}} + c \qquad (2)$$

For simulator head in PMMA, these coefficients have the following values: a = 0.4738, b = 0.8045 c = 0.0752.

In the method presented by Yu et al [4] and Sawyer [5], the *air- kerma* index for computed tomography, C_{air} was replaced by the average dose in the central plane $\bar{D}$ and *kerma* weighted index for computed tomography measured in the simulator PMMA, $C_{w,PMMA}$ is replaced by the weighted average dose in PMMA, $D_{w,PMMA}$: $C_{air} \rightarrow \bar{D}$ and $C_{w,\ PMMA} \rightarrow D_{w,PMMA}$. Table 1 shows the values of $\bar{D}$ and $D_{w,PMMA}$. Where D_w is obtained by Equation 3.

$$D_w = \frac{1}{3} \times \bar{D}_{center,PMMA} + \frac{2}{3} \times \bar{D}_{periphery,PMMA} \qquad (3)$$

3 - RESULTS AND DISCUSSION

We obtained values of effective dose compatible with a volumetric acquisition, and, therefore, superior to the typical values of panoramic image. This study suggests a direct and practical way to estimate values of effective dose for cone beam CT in dental applications, thereby allowing simpler way to compare protocols and equipment. Unlike methods that use this methodology TLDs, it can be applied by the user of the equipment, requiring only prior knowledge of the index $\bar{D}$ and $D_{w,PMMA}$.

Table 1 - Values of D and $D_{w,PMMA}$ for cone beam CT scanners. i-CAT, 120 kV / 9.65 mAs.

Equipment	i-CAT (a)			i-CAT (b)			i-CAT (c)			i-CAT (d)		
	FOV (cm)			FOV (cm)			FOV (cm)			FOV (cm)		
Indices	*6*	*8*	*13*	*6*	*8*	*13*	*6*	*8*	*13*	*6*	*8*	*13*
$\bar{D}$ (mGy)	17.17	17.38	17.54	16.87	17.12	17.01	17.01	17.09	17.24	16.01	16.11	16.95
$D_{w.PMMA}$ (mGy)	1.16	1.18	1.24	1.13	1.16	1.21	1.14	1.14	1.19	1.06	1.11	1.14
(a). (b). (c) e (d) identify the equipment with the same configuration.												

Table 2 - Values of effective dose for cone beam CT scanners for various examination protocols.

Equipment	i-CAT (a)			i-CAT (b)			i-CAT (c)			i-CAT (d)		
	FOV (cm)			FOV (cm)			FOV (cm)			FOV (cm)		
	6	8	13	6	8	13	6	8	13	6	8	13
Protocol	Effective Dose (μSv) - ICRP 103											
1			82			82			82			76
2		108			104			104			92	
3	36			36			36			32		
4	42			42			42			40		

Table 3 - Comparison between the values of effective dose for the i-CAT equipment and conventional tomography.

	Protocol	*E* (μSv)		Ratio E_{TC}/E_{TCFC}	Equivalent in panoramic images
References		CT	CBCT		
Loubele *et al* [7]	Mandibular	474-541	34	13.9-15.9	
Ludlow [6]	Full	534-860	69	7.8-12.5	4
CT – Computed Tomography Conventional; E – Effective Dose.					

4 - CONCLUSIONS

This study suggests a direct and practical way to estimate effective dose values for cone beam CT in dental applications using spreadsheet and a commercial database of Monte Carlo simulation. Unlike methods using TLDs, this methodology can be applied by the user of the equipment requiring only prior knowledge of the indices $\bar{D}$ and $D_{w,PMMA}$.

The estimated values are low compared with the values of effective doses generated from conventional tomography. However, these values are relatively high when compared with the typical effective dose values derived from other types of radiological examinations present in dentistry. The panoramic images in dentistry are responsible for values of effective doses approximately four times lower than those derived from volumetric acquisitions. This makes clear the importance of evaluation and the rational use of new technologies [8].

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