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The Comparison of Entrance Surface Radiation Dose to the Thyroid Gland Region in Different Dental Panoramic Radiography

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Abstract: Introduction: The proven radio sensitivity and the position of the thyroid gland make it a significant organ during the dental radiography exposure. Objectives: This study compared the surface radiation dose to the thyroid gland region during two different techniques of two dimensional (2D) conventional orthopantomography (OPG) and three dimensional (3D) OPG reconstructed from cone beam computed tomography (CBCT). Methods: The entrance surface dose to the thyroid region of the patients was evaluated using a personal dosimeter in a sample of 156 patients who prescribed for an OPG examination. Results: The obtained mean dose values for conventional OPG and reconstructed OPG from CBCT are 7.47 μSv and 28.65 μSv, respectively. Further a significant difference ($p < 0.05$) was observed between those two doses. Conclusions: A significant amount of dose reduction to the thyroid gland region can be obtained when using conventional OPG compared to the CBCT.

Key words: Orthopantomography, cone beam computed tomography, thyroid gland region.

1. Introduction

In a department of radiography, there are several procedures and steps implemented on par to standard protocols to ensure to obtain the optimum image quality with the least possible radiation dose. This is referred to as ALARA (as low as reasonably achievable) [1]. As the thyroid gland is high radio-sensitive and has higher chances for the incidence of cancer, it is exceptionally essential in maintaining low radiation dose to it, especially when there is routine follow up procedures [2].

The orthopantomography (OPG) examination is one of the most chosen examinations before the orthodontic treatment. It was also shown that the major absorbed dose to the thyroid gland receives from this examination. Therefore, optimization of radiation doses in OPG may be seen as a necessary step as many children and adolescents will be subjected at OPG examinations in connection to orthodontic treatment planning. Basically, three types of: conventional, digital and reconstructed from cone beam computed tomography (CBCT) imaging modalities are available to obtain OPG. The radiation dose from an OPG examination to the thyroid gland is, however, rather small, despite that a cautious attitude should be taken to reduce the radiation dose to the thyroid gland of children and adolescents [3]. However, in general practice, the radiation protective gears are not provided to the patients due to the relatively low radiation exposure from dental X-ray machines. In these instances, it is really essential to select the optimum imaging modality with minimum possible level of radiation to minimize any unnecessary exposure to the thyroid gland. This study conducted to evaluate the surface radiation dose to the thyroid gland region during two different imaging techniques of two dimensional (2D) conventional orthopantomography (OPG) and three dimensional (3D) OPG reconstructed from cone beam computed tomography (CBCT). By

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measuring the dose to the thyroid gland in different OPG modalities assist in coming up with protective measures or intervening the practiced method to ensure the least possible dose is given to the patient.

2. Method

A prospective study was conducted on a sample of 156 consented patients who were prescribed for OPG by clinicians in the Radiology Unit of the Faculty of Dental Sciences, University of Peradeniya, Sri Lanka during the study period. Permissions were sought from the concerned authorities after taking the ethical clearance from the Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka. This study was done to compare the radiation doses of conventional OPG and OPG reconstructed from CBCT. Patients selected for this study were referred by the clinician during the routine procedure of the hospital and there were no changes or influence by the radiographers and investigators to change the imaging modality. The radiation dose on the skin on the thyroid gland was measured using an Electronic Personnel Dosimeter (EPD, PD-117 manufactured by Hitachi Aloka Medical, Ltd., Tokyo, Japan) which was placed at the isthmus level of the thyroid of the patient. Programmed exposure parameters were selected (Conventional OPG average kV = 70 and mAs = 7, CBCT average kV = 78 and mAs = 20). Same patient positioning technique was used for all two imaging modalities. However, the image receptor was varied according to the imaging modality.

Following each exposure, the immediate reading of the dosimeter was recorded. However, backscatter radiation was also included in the recorded dose. The independent variables of this study were: the type of imaging modality. The dependent variable is the radiation dose to the thyroid gland. The same dosimeter was used in the two modalities to avoid zero-calibration error.

3. Results

The obtained mean values for each imaging modality are demonstrated in Table 1. A statistically significant dose difference was found between two imaging modalities.

4. Discussion

This study conducted to evaluate the surface radiation dose to the thyroid gland region during conventional OPG and OPG reconstructed from CBCT. The specific dose values obtained here are difficult to compare with the literature, owing to the many different protocols, machines, exposure parameters, methods of measurement and dosimetry systems. Nevertheless, different imaging modalities should be tested further to decide whether or not they deliver less radiation [4].

The current study was done to evaluate the actual setting rather than an experimental setting. Therefore, the same dosimeter and the pre-set protocols and exposure factors which daily utilize by the radiographers in the study setting were used in this study. It was also noted that all the measured radiation doses to the thyroid gland region during all the OPG examinations in this study were within the diagnostically acceptable limit (< 74.1 mGy cm^2 for adult) [5]. According to Ref. [6], conventional OPG could detect pathologies in a similar way as other imaging modalities. Regarding caries diagnosis and restoration assessability, conventional OPG showed the highest accuracy. The diagnostic value of CBCT was limited by the occurrence of beam-hardening artefacts and streaks from restorations and implants [7].

Table 1 Comparison of received dose between conventional OPG and OPG reconstructed from CBCT.

Imaging modality	Number of subjects	Mean dose (± SD)	*p* value
Conventional	120	7.47 μSv (± 2.66)	
CBCT	36	28.65 μSv (± 3.77)	< 0.05

According to the results, a significant reduction can be achieved by using conventional OPG than OPG derived from CBCT. This finding was supported by the several previous studies. Signorelli et al. [8] determined radiation doses of different CBCT scan modes in comparison to a conventional set of orthodontic radiographs by means of phantom dosimetry. Similar to the current study results, they found minimum effective dose in set of conventional orthodontic radiographs than CBCT. They also mentioned that although one CBCT scan may replace all conventional set of orthodontic radiographs (CORs), one set of CORs still entails 2-4 times less radiation than one CBCT. Depending on the scan mode, the radiation dose of a CBCT is about 3-6 times an OPG. They also suggested that CBCT should not be recommended for use in all orthodontic patients as a substitute for a conventional set of radiographs. In CBCT, reducing the height of the field of view and shielding the thyroid are advisable methods and must be implemented to lower the exposure dose. A similar result was also obtained by Shin et al. [9] who estimated the effective dose for panoramic radiography is 6.39 μSv and CBCT is 50.6-428.3 μSv. They concluded that CBCT doses were higher than those of panoramic radiography

Grünheid et al. [10] compared the effective doses to different target areas in the head and neck phantom in CBCT, digital panoramic and digital lateral cephalometric machines. They demonstrated the variation of the effective doses in CBCT with different resolution settings. They achieved 64.7 to 69.2 mSv effective doses for standard resolution CBCT scan and concluded that although providing additional diagnostic and therapeutic benefits, CBCT exposes patients to higher levels of radiation than conventional digital radiography.

Therefore, it is the professional accountability of a conscientious medical staff to weigh the proven and apparent benefits of diagnosis against the risks to which the patient is exposed.

5. Conclusions

This study concludes that the highest exposure to the thyroid gland was received during the OPG reconstructed from CBCT in comparison to the conventional OPG. A significant amount of dose reduction to the thyroid gland region can be obtained when using conventional OPG compared to the CBCT.

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None.

Conflict of Interest

The authors declare no competing interests.

Ethical Statements

Ethical approval was obtained from the Ethical Review Committee of the Faculty of Allied Health Sciences, University of Peradeniya.

Informed consent was obtained.

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