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Comparison of the Absorbed Dose of Target Organs between Conventional and Digital Panoramic Radiography

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ABSTRACT

The purpose of this study was to measure and compare target organ's exposure by direct digital and conventional panoramic radiography. Dose measurements were carried out on a RANDO phantom, which TLDs were placed into 5 target area: thyroid gland, left and right submandibular and parotid salivary glands. Panoramic radiographs were taken with two conventional (CRANEX Tome, Soredex, Tusula Finland) and direct digital devices (CRANEX D, Soredex, Tusula Finland).In total, the phantom was irradiated 30 times in the two systems. The TLDs were then coded and analyzed. T-test of statistical analysis was used to find the correlation. We found statistically significant reduction in absorbed dose of target organs in digital panoramic radiography(P<0.01). The highest absorbed dose was for submandibular gland and the lowest was for thyroid gland. We concluded that can reduce absorbed dose in vital organs.

Keywords: Dosimetry, Conventional Panoramic, Digital Panoramic, Thyroid Gland

INTRODUCTION

Minimizing the absorbed dose of target organs receiving X ray radiation is a major concern for dentists and especially oral and maxillofacial radiologists. Critical organs such as the thyroid gland, active bone marrow, salivary glands and brain are present in the head and neck region and are susceptible to the late effects of X radiation. Possible late effects of diagnostic X ray radiation are worrisome not because of high radiation doses, but because of unnecessary irradiations. Preventing the risk of ionizing radiation and use of methods and equipment that approximate the exposure conditions to ideal is an important step in protection against radiation and dose reduction in diagnostic radiography. Some studies have stated that, in contrast to digitalintra-oral radiography, no significant dose reduction occurs by replacement of extra-oral conventional systems with digital radiography; whereas, some others have reported a significant dose reduction when using extra-oral digital radiography systems Due to the extensive use of lateral cephalometric radiography especially in orthodontic treatments and orthognathic surgery, it is especially important to obtain radiographs with the highest quality and minimum absorbed dose of patients and clinicians. CRANEX Tom conventional lateral cephalometric radiography (Cranex Tome Ceph; Soredex, Helsinki, Finland) and CRANEX D PAN digital lateral cephalometric radiography (CRANEX D PAN/Ceph, Soredex, Helsinki, Finland) have been recently introduced to the market and have not been compared in terms of absorbed dose of organs. Thus, the present study sought to compare the absorbed dose of sensitive organs in the head and neck region between conventional and digital lateral cephalometric radiographies.

The effects of radiation exposure can occur a long time after exposure, included radiation induced malignancy and genetic effects. The health aspects of diagnostic exposure are the main concern of technologists and radiologists.

Critical organs such as thyroid gland and salivary glands are in the head and neck region are sensitive to long term stochastic effects of radiation exposure[1-3] Frequency of x-ray examination is increased among all age groups, therefore radiation exposure should be kept as low as reasonably achievable more than before [1].

The panoramic radiography has been widely employed not only in the diagnosis but also in the treatment plan of patients. Digital panoramic radiography has some advantages included bypassing chemical processing and not to commitment of processed film storing [2].

Some studies revealed significant dose reduction in digital panoramic radiography compare to conventional film-screen panoramic [4,5]. Some studies found no significant difference between two mentioned techniques. Due to inadequate published data, the aim of this study is to compare absorbed dose of thyroid and salivary gland between conventional and digital panoramic radiography. The purpose of this study was to measure and compare target organ's exposure by direct digital and conventional panoramic radiography.

MATERIALS AND METHODS

In this study we used a human's phantom head called RANDO phantom (Radiation Analog Dosimetry system, Rando Alderson, USA). The phantom was divided into parallel portions of 2.5 cm thickness which had embedded the holes(5*25 mm) in shapes of cylindrical, that dosimeters placed in them[4,6]

To achieve the main goal of the study, we used Lithium fluoride Thermoluminescence crystals (TLD100) in shape of square (size: 1*3*3 mm) [1].These TLDs can be repeatedly used, and to measure small doses are very accurate and useful. The TLDs were placed into phantom head sections and the phantom were positioned in two panoramic devices: conventional panoramic device (CRANEX Tome, Soredex, Tusula Finland) and digital panoramic device (CRANEX D, Soredex, Tusula Finland).We applied 66KVp, 15mA, 15s of exposure condition for conventional radiography due to achieve optimal quality. We also used 57KVp, 10mA, 11s exposure condition to digital radiography with CCD detector.[7]We exposed phantom head 10 times to gain readable doses, and that was repeated for 3 times to increased accuracy of dose measurements (A total of 30 times for each panoramic device). Then the TLDs were left without hand contacts and they coded and analyzed by TLD analyzer in Atomic Energy Organization of Iran. The mean absorbed dose of each target organ were calculated and the study employed the use of T-test for statistical analysis.

RESULTS AND DISCUSSION

The panoramic radiography has been widely employed not only in the diagnosis but also in the treatment plan of patients. Digital panoramic radiography has some advantages included bypassing chemical processing and not to commitment of processed film storing. Some studies revealed significant dose reduction in digital panoramic radiography compare to conventional film-screen panoramic some studies found no significant difference between two mentioned techniques. Due to inadequate published data, the aim of this study is to compare absorbed dose of thyroid and salivary gland between conventional and digital panoramic radiography. In this study the mean absorbed dose of 5 target organs were calculated after 30 time exposure in two different conventional and digital panoramic devices. Table 1 shows the results of thyroid, submandibular and parotid glands. There was statistically significant difference in target organs absorbed doses between two conventional and digital panoramic radiography (P-Value<0.01). The digital panoramic radiography had statistically significant reduction in organs absorbed dose.

The submandibular glands had the highest absorbed dose and thyroid gland had the lowest (Figure 1) and as a results of t-test they both have significant reduction dose in digital panoramic radiography (P-Value<0.01).

Table1: Mean absorbed dose of target organs in conventional and digital panoramic

Target organ	Conventional	Digital	P-Value
Thyroid gland	0.022±0.001	0.008±0.0002	P<0.01
Parotid gland L	0.050±0.003	0.026±0.003	P<0.01
Parotid gland R	0.051±0.002	0.026±0.005	P<0.01
Submandibular gland L	0.180±0.002	0.116±0.001	P<0.01
Submandibular gland R	0.182±0.004	0.117±0.003	P<0.01

The main purpose of this study was to compare the absorbed dose of target organs between the conventional and the digital panoramic systems. We found significant difference between two techniques and use of digital panoramic system had been far less radiation dose to the target organs. The significant difference was also observed in all 5 considered area.

In a study by Garsia Silva, Effective dose of conventional and digital panoramic images as a scout for CBCT was evaluated. Similar to our results, they found minimum dose in conventional panoramic system (2.7 µSV). [8] They didn't had studied salivary gland absorbed dose separately.

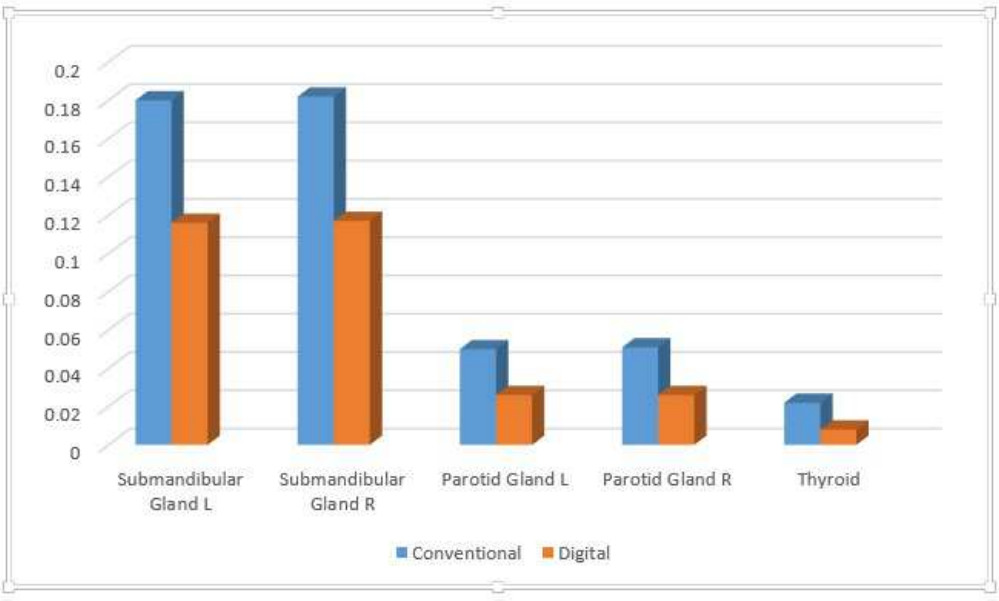

Figure 1: Mean Absorbed Doseof target organs in Conventional Versus Digital panoramic

In a study conducted in 2008 by Alkurt et al, an evaluation of dose reduction on image quality of panoramic radiographs was made. They found 25% dose reduction for digital images without loss of quality.[5]however they did not study absorbed dose of salivary glands, in line with our results, absorbed dose reduced in digital panoramic systems.

In another study by Grunheid et al, in 2012, they compared absorbed dose of target organs in CBCT, digital panoramic and lateral cephalometric machines. They used RANDO phantom and TLDs and concluded that absorbed dose of target organs in digital panoramic systems significantly decreased. [9] They didn't compare conventional and digital panoramic systems and absorbed dose of salivary glands was not evaluated.

Similar results were obtained in another study by Talaeipour et al, in 2013. They compare absorbed dose of target organs in two conventional and digital cephalometric radiography and they revealed that digital system caused a significant reduction in absorbed dose of target organs. [10] They didn't compared conventional and digital panoramic systems.

In a study by Noujeim in 2011, Compared conventional panoramic with digital (CCD sensor) panoramic radiography using RANDO phantom. Results showed that high quality images can be achieve by low dose radiation in digital system. [11] In mentioned study, they focused on image quality and absorbed dose of salivary glands were neglected.

In another pertinent study, Gijbels et al, in 2004, compared the indirect (PSP) and the direct (CCD) digital lateral cephalometric radiography. The results of this study demonstrated that direct digital system generated higher dose when compared to the PSP system, even though diagnostic quality remained similar. They attributed the difference in the absorbed dose targets to the variance in the nature of exposure amid the two systems [6].

Increased absorbed dose in conventional systems may cause by higher mA to achieve appropriate quality. Digital radiography provides high resolution x-ray images at a low radiation dose. Also digital sensors have linear dose-response and contrast is not dose related. So high quality images can be obtained due to contrast improvement ability in digital systems.

CONCLUSION

A significant difference observed in absorbed dose of target organs between conventional and digital panoramic techniques. The direct digital system caused dose reduction compare to conventional film-screen panoramic.The purpose of this study was to measure and compare target organ's exposure by direct digital and conventional panoramic radiography. Dose measurements were carried out on a RANDO phantom, which TLDs were placed into

5 target area: thyroid gland, left and right submandibular and parotid salivary glands. Panoramic radiographs were taken with two conventional (CRANEX Tome, Soredex, Tusula Finland) and direct digital devices (CRANEX D, Soredex, Tusula Finland). In total, the phantom was irradiated 30 times in the two systems. The TLDs were then coded and analyzed. T-test of statistical analysis used to find the correlation. We found statistically significant reduction in absorbed dose of target organs in digital panoramic radiography($P<0.01$). The highest absorbed dose was for submandibular gland and the lowest was for thyroid gland. We concluded that can reduce absorbed dose in vital organs.

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