A STUDY ON THE EFFECTS OF SCATTERING DOSE ON EYES AND THYROID FOR PANORAMAGRAPHY
(Focus on TLD and PLD)

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This study concerning the surface dose of eye and thyroid from panoramagraphy used thermoluminescent dosimeter (TLD) and photoluminescent dosimeter (PLD) to take measurements at ten hospitals in the Gwangju metropolitan area. The recommendations from ICRP 60 and ICRP 73 on the allowance standard for eye are 15 mSv and for thyroid is 1 mSv. The left eye TLD and PLD values are 0.19 mSv and 0.24 mSv respectively. The right eye TLD and PLD values are 0.23 mSv and 0.25 mSv respectively. Thyroid TLD and PLD values are 0.08 mSv and 0.25 mSv respectively and did not exceed the allowance standards($p<0.001$). Also comparisons are made between TLD and PLD for each organ and PLD has higher dose measurements than TLD. There are statistically significant differences in left eye measurements and thyroid measurements ($p<0.01$). There is no significant difference in measurements for the right eye ($p>0.05$). The TLD and PLD measured dose from panoramagraphy instruments on eyes and thyroid from each hospital did not exceed the recommended dose from ICRP 60 for surface dose measurements. However, due to the probability of influence, consideration should be made for all levels of dose.

Keywords : Panoramagraphy, TLD, PLD, Surface Dose

1. INTRODUCTION

Dental panorama equipment uses x-ray for diagnostic purposes as it is low in cost and simple to use so much that all information regarding dental and jawbone status uses this procedure for dental treatment and periodic medical checkups. Also there are many changes occurring in dimensional image analysis with the introduction of digital systems and computer tomography (CT). As a result the frequency of radiological exams has increased compared to the past. Panorama radiography imaging as it pertains to the maxillofacial region is a useful method of evaluating the diagnosis of disease, establishing treatment plans, treatment results and prognosis; however, Panorama radiography uses ionization radiation and therefore it can cause for cataract and acute lens damage or chronic problems such as carcinogenesis, deformities, and mutations [1]. Particularly due to the small quantity of ionization radiation used to inspect the head and cervical region, carcinogenesis can occur and there are reports providing evidence that after diagnostic radiation imaging the likelihood of an attack from leukemia increases [2]. There is a need to use minimal dose due to side effects such as damage to the thyroid, which normally promotes the body's metabolism process by controlling hormone production and storage functions, its ability to regulate growth is destroyed and tumors form or genetic mutations develop into thyroid cancer, cell extinction and functional paralysis from damaged DNA in the fragile eye lens, skin erythema, blisters, ulcers, cataract, and production of cancer cells. Since there is no evidence implying that no dangers exist from the small quantity of surface dose from panorama imaging there needs to be efforts made to reduce the exposure of radiation as much as possible. There is also

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a need for a systematic explanation of the risks from radiation by dentists to patients. Therefore this study explains the risks of radiation to eyes and thyroid from a survey and remains cognitive of the importance of the recommendations from ICRP 60 on dose limits.

2. STUDY OBJECT AND METHODS

2.1 Experiment Object

This experiment measured the surface dose of eye and thyroid panoramagraphy at ten hospitals in the Gwangju/Jeonnam area. TLD and PLD were used at each hospital to measure the exact amount of surface dose. A total of one hundred TLDs and one hundred PLD were used by taping them to left and right eyes and thyroid in order to fix their position and the tube went from left to right. When images were taken, the Phantom was supported to so as to minimize movement which may cause errors in the measurements. Once the Phantom was properly fixed, the imaging process began with ten repeated measurements of surface dose. During measurements radiation protection and safety according to ICRP 60 regarding dose limits are shown on Table 1.

Table 1. Recommended Dose Limits in Planned Exposure Situations.

Type of limit		Occupational	Public
Effective Dose		20 mSv per year (Averaged over defined periods of 5 years)	1 mSv in a year
Annual equivalent dose in	Leans of eye	150 mSv	15 mSv
	Skin	500 mSv	50 mSv
	Hands and feet	500 mSv	-

Table 2. The Name of Panorama Machines, kVp, mA, sec.

Hospital	Panorama machines	N	Tube Voltage	Tube current	Sec
A	Orthoceph OC100H	10	70kVp	10mA	17.6
B	PAX400	10	62kVp	5mA	12
C	VATECH	10	66kVp	6mA	13
D	Orthoceph OC100	10	66kVp	4mA	13.9
E	ORTHOPHOS313C	10	70kVp	10mA	11.3
F	ORTHOPANTOMOGRAPH OP-100	10	74kVp	12mA	17.6
G	ORTHOPHOS3	10	76kVp	11mA	11.1
H	VATECH	10	66kVp	8mA	10
I	dimax3ceph	10	66kVp	13mA	16
J	Orthoceph OC100	10	66kVp	3.2mA	17.6
	Total	100			

2.2 Experiment Tools and Materials

Experimental tools used in this study were Orthoceph OC100, PAX400, VATECH, ORTHOPHOS313C, ORTHOPANTOMOGRAPHOP-100, ORTHOPHOS3, and dimax3 ceph for panoramagraphy, Carot, Japan for TLD, GD-450, Japan for PLD, phantom, and phantom support. The TLD automatic decoding equipment was UD-710R, Panasonic, Japan and the PLD automatic decoding equipment was FGD-650, Japan.

2.3 Statistical Treatment

SPSS ver. 15.1 was used for data analysis. A one-way ANOVA was used to compare dose according to the hospital. Also each hospitals surface dose frequency and statistical data was taken. Comparisons of surface dose from TLD and PLD in left eye, right eye, and thyroid were

Table 3. TLD and PLD's Result of Left Eyes. (Unit : mSv)

Item	Classification	N	TLD			PLD		
			GM±GSD	F	p	GM±GSD	F	p
Left eye	A	10	0.13±0.008	12.701	0.000***	0.19±0.045	192.059	0.000***
	B	10	0.13±0.025			0.11±0.002		
	C	10	0.34±0.10			0.29±0.005		
	D	10	0.15±0.015			0.44±0.015		
	E	10	0.10±0.008			0.17±0.006		
	F	10	0.27±0.036			0.27±0.004		
	G	10	0.20±0.034			0.27±0.006		
	H	10	0.17±0.028			0.13±0.004		
	I	10	0.27±0.098			0.30±0.005		
	J	10	0.15±0.015			0.19±0.006		
	Total	100	0.19±0.088			0.24±0.094		

Note) Interaction effect using one-way ANOVA model : ***p<0.001

Table 4. TLD and PLD Results for Right Eyes. (Unit : mSv)

Item	Classification	N	TLD			PLD		
			GM±GSD	F	p	GM±GSD	F	p
Right eye	A	10	0.16±0.067	23.316	0.000***	0.34±0.001	40.769	0.000***
	B	10	0.17±0.019			0.55±0.009		
	C	10	0.35±0.103			0.15±0.002		
	D	10	0.20±0.015			0.27±0.007		
	E	10	0.22±0.097			0.95±0.003		
	F	10	0.14±0.014			0.11±0.003		
	G	10	0.34±0.027			0.11±0.004		
	H	10	0.13±0.013			0.36±0.008		
	I	10	0.45±0.040			0.32±0.008		
	J	10	0.18±0.008			0.21±0.007		
	Total	100	0.23±0.111			0.25±0.147		

Note) Interaction effect using one-way ANOVA model : ***p<0.001

compared using independent samples t-test with p-value determined as $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Panoramagraphy Equipment Name and Imaging Conditions

Table 2 displays the panorama machines and conditions of usage for each hospital investigated in this study.

3.2 Comparison of Left Eye Dose Value from TLD and PLD

Table 3 displays the mean TLD and PLD values for left eye measurements at 0.19 mSv and 0.24 mSv. Dose equivalent did not exceed the recommendation of ICRP of 15 mSv. There is a statistically significant difference at each hospital according to measured dose ($p < 0.001$).

3.3 Comparison of Dose Value from TLD and PLD for Right Eye

Table 4 displays the mean TLD and PLD values for right eye measurements at 0.23 mSv and 0.25 mSv. Dose equivalent did not exceed the recommendation of ICRP for eyes of 15 mSv. There is a statistically significant difference at each hospital according to measured dose ($p < 0.001$).

3.4 Comparison of Dose Value from TLD and PLD for Thyroid

Table 5 displays the mean TLD and PLD values for thyroid measurements at 0.08 mSv and 0.25 mSv. The test did not exceed the recommendation of ICRP for annual effective dose of 1 mSv. There is a statistically significant difference at each hospital according to measured dose ($p < 0.001$).

Table 5. TLD and PLD Results for Thyroids. (Unit : mSv)

Item	Classification	n	TLD			PLD		
			GM±GSD	F	p	GM±GSD	F	p
Thyroid	A	10	0.04±0.008	46.088	0.000***	0.25±0.004	38.305	0.000***
	B	10	0.05±0.016			0.30±0.004		
	C	10	0.11±0.020			0.31±0.008		
	D	10	0.05±0.008			0.16±0.001		
	E	10	0.08±0.025			0.22±0.078		
	F	10	0.03±0.008			0.30±0.006		
	G	10	0.17±0.037			0.30±0.005		
	H	10	0.07±0.004			0.33±0.005		
	I	10	0.05±0.005			0.14±0.005		
	J	10	0.18±0.007			0.17±0.005		
	Total	100	0.08±0.053			0.25±0.070		

Note) Interaction effect using one-way ANOVA model: ***p<0.001

3.5 Comparison of Dose Values from TLD and PLD

Table 6 is a comparison of dose values of TLD and PLD using an independent sample t-test and the measurements show higher dosage in PLD than TLD for left eye, right eye and thyroid results.

The dosage value measurements for PLD from a rotation method of panorama imaging were higher than TLD. There are statistically significant differences for left eye and thyroid ($p < 0.01$). There is no significant difference for right eye ($p > 0.05$).

Table 6. Compare with TLD and PLD. (Unit : mSv)

Location	Dosimetry	N	GM±GSD	t	p
Left eye	TLD	100	0.19±0.088	-3.056	0.004**
	PLD	100	0.24±0.094		
Right eye	TLD	100	0.23±0.111	-0.526	0.602
	PLD	100	0.25±0.147		
Thyroid	TLD	100	0.08±0.053	-13.207	0.000***
	PLD	100	0.25±0.070		

Note) Interaction effect using t-test model: **p<0.01, ***p<0.001

There exists radiation surface level measurement research on radiograph tomography according to exposure terms, distance change between radiation source and skin, premature level changes, and changes in filtration degree. Also Brooks and Lanzetta measured surface dose of head and neck region from temporomandibular joint tomography [3]. Research conducted on surface dose of radiation from panorama radiograph imaging was first done in 1965 by Priv-Doz in regards to measuring gonadal doses [4]. It was followed by Kuba and Beck's study on radiation surface dose of the head and neck area from panorex tomography [5], Manson-Hing and Greer's study on radiation exposure and distribution according to panoramic X-ray machines [6], Myers' study on radiation surface dose of children [7], and Whitcher, Grant, and Sickles study of decreasing surface dose with use of lead apron [8]. Also, there were studies by Skoczylas who compared the radiation surface dose according to various panoramic radiolgraphic techniques [9], Updegrave [10], Aken and Linden [11], Wall [12], and White and Rose [13]. In the ICRP Publication 60: 1990 Recommendati-ons of the International Commission on Radiological Protection, 60, the annual dose limit for a general person's thyroid gland is 1 mSv [14]. Within weeks to years, chronic thyroiditis can originate from a beginning dose of 10 Gy. Considering this, the numerical value is insufficient compared to beginning dose of 0.127 mGy and 0.062 mGy. However, there is still a lack of properly conducted examinations on the influence of very low dose of radiation on the human body even with the present philosophy that radiation, no matter how slight, is harmful to the human body. Because radiation can trigger a biological effect, its use should be controlled. Each country and every organization is enforcing the limits of dose. However, if there is no authority to limit diagnostic medical radiation dose then there is a need to follow the rule of ALARA "*As Low As Reasonably Achievable*." For radiation protection ICRP, United Nations Atomic Energy Commission, and other international organization present standards in dose and state that 7 mGy is appropriate for one dental root radiograph image and skin surface dose. In general, when taking dental root radiograph image changes in the exposure dose and the surface level of patients involves kVp, mA, distance, and exposure at various locations on the body but as a whole measured exposure dose of one image of radiograph to be approximately 217 mR. From the results of this study we can gain some overall knowledge in regards to surface level dose in patients' crystalline lens and thyroid gland from panorama imaging. Primary data concerning the effectiveness of panorama imaging is provided and can be used as reference material for radiation imaging of crystalline lens and thyroid glands

4. CONCLUSION

This study used phantoms to examine the influences of radiation dose on eyes and thyroid glands from panorama instruments in use at hospitals. The measurements were analyzed for significance using a t-test. The results of the analysis are as follows:

1. The terms of usage for panorama instruments were different at each hospital.
2. There is a statistically significant difference in surface level dose in left eye for each hospital with TLD at 0.19 mSv and PLD at 0.24 mSv($p<0.001$).
3. There is no statistically significant difference in surface level dose in right eye for each hospital with TLD at 0.23 mSv and PLD at 0.25 mSv($p<0.001$).
4. There is a statistically significant difference in surface level dose in thyroid for each hospital with TLD at 0.08 mSv and PLD at 0.25 mSv($p<0.001$).
5. The PLD measurements for left eye, right eye, and thyroid were higher when compared to TLD measurements.

From this study it became apparent that PLD dose measurements from panorama imaging are more sensitive to direction than TLD measurements. PLD was more efficient in taking measurements of panorama imaging while rotating due to its sensitivity to direction. From the results dose received by the body differs according to the conditions for the equipment used for panorama imaging. Even though this study made sure exposure was less than the recommendations of ICRP 60 for eye and thyroid surface dose, considerations were made for the possibility

of influence from even the smallest dose. Therefore, in order to minimize the exposure dose to patients when shooting panorama imaging, each hospital not only followed ALARA guidebook but also made efforts to manage exposure to eyes and thyroid through accuracy and establishing proper conditions for panorama imaging.

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