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The Knowledge, Attentions and Behaviors of Radiation Safety Management by Dental Health care Workers

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치과종사자들의 방사선 안전관리에 대한 지식 및 행태

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Abstract The purpose of this study examines the education, knowledge and behavior of radiation safety management among dental workers and compares the education, knowledge and behavior between dental hygienist group and other occupational groups. This study was conducted from November 2nd to November 14th, 2019. The survey was conducted on dental workers(dental hygienists, nursing, assistants, coordinators, etc.) who worked in dental hospitals and clinics in Busan area. The tool of this study was modified and adapted to the clinical setting based on the questionnaire. Radiation safety education has 39 dental hygienists who had more education than non-dental hygienists ($p=0.286$). The most common types of radiation safety education were self-education which usually performed by dentistry, followed by conservative education and others. The average of radiation attitudes, knowledge and behaviors was higher in the dental hygienist group than in the non-dental hygienist group. On the item-specific behavior among employees, the question of 'the radiation should be shielded according to the menstrual cycle or pregnancy of the woman of childbearing' was significant ($p<0.05$). On the item-specific knowledge between occupations, the question of 'the intensity of X-rays decreases over distance' and 'the individual exposure can be measured by TLD badge or film badge' was significant ($p<0.05$). Taken together, these results indicate that the dental hygienist group is more concerned about radiation safety and that the dental hygienist group is receiving more radiation safety management training. However, if there is a low level of 'has experienced' in the presence or absence of safety management education, it is difficult to train radiation safety management in dentistry. Therefore, it is considered that dentists should be trained in radiation safety management periodically to pay attention to radiation safety accidents.

Key Words: Radiation, Radiation safety management, Knowledge, Behaviors, Attention

중심 단어: 방사선, 방사선 안전관리, 지식, 행동, 태도

I . Introduction

X-rays were first discovered by Roentgen in 1895 and made it possible to visualize and diagnose information

through film. In modern medicine, radiation is used for medical diagnosis, treatment and research of humans which has played an important role in protecting and advancing medicine[1-3].

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In addition, oral care institutions are using radiation to diagnose oral disease and establish treatment plans using radiation. In recent years, the share of the radiation in the oral cavity as well as off-campus radiography, panorama shooting, and digital radiography is increasing rapidly. However, in the medical field, radiation has significant benefits for diagnosis and treatment, while also being a barrier to radiation exposure[4]. Even a small amount of medical radiation can be affected by long-term radiation. Therefore, dental workers working with radiation should know the basic knowledge, behavior and attitudes of radiation in order to protect themselves and their patients, and should be inclined not to exceed the maximum allowable dose of radiation exposure[5].

Regarding the safety management of radiation, radiation workers have received safety training and attention. However, the treatment of radiation in the clinic neglects the safety management of the radiation because the busy work neglects the attention and the continuous maintenance training is not provided. Therefore, in the clinic, regular training on the safety management of radiation should be carried out[6].

Therefore, this study examines the education, knowledge and behavior of radiation safety management among dental workers and compares the education, knowledge and behavior between dental hygienist group and other occupational groups and can supplement it by radiation safety management which wanted to prepare the basic materials for preparing the education system.

II. Subjects and Method

1. Subjects and data collection

This study was conducted from November 2nd to November 14th, 2019. The survey was conducted on dental workers(dental hygienists, nursing, assistants, coordinators, etc.) who worked in dental hospitals and clinics in Busan area.

The data collection of this study was surveyed through a questionnaire. 150 copies of the questionnaire was distributed and the recovery rate was 78% which was

118 copies of it.

2. Method and contents

The tool of this study is the questionnaire, which was modified and adapted to the clinical setting based on the questionnaire used in the study of Kim[1]. The content of the questionnaire includes 11 questions of the general characteristics of the dental workers (gender, occupation, age, marital status, workplace, years of service, equipment status, radiation defense facilities, training status, number of safety trainings), 12 questions about the knowledge of radiation, 11 questions of the attitude and behavior of radiation defense equipment management, radiation exposure, operators and guardians, and 11 questions of the radiation safety management on the patient's side respectively.

3. Statistical analysis

Radiation safety management behaviors, attitudes, and knowledge were measured on a five-point scale, and the higher the score, the higher the behavior, attitude and knowledge. The collected data were analyzed using SPSS 24.0 statistical program. The main analysis techniques are as follows.

1) The general characteristics of the subjects and the status of dental equipment were analyzed by frequency analysis.

2) Average comparison of attitude behavior knowledge between dental hygienists and another group of dental hygienists was used as the student *t*-test.

3) Items related to radiation safety management education were analyzed by cross analysis.

III. Results

1. General characteristics of the subject

There were 118 dental workers consisting of 112 females(94.9%) 6 males(5.1%) which shows females were far more prevalent in terms of occupational

Table 1. General Characteristics

Characteristic	Sort	Number	%
Gender	Male	8	5.1
	Female	112	94.9
Occupations	Dental Hygienist	70	60.1
	Others	48	31.3
Age	20~30	91	77.1
	31~40 and over	27	22.6
Marital Status	Married	30	25.4
	Single	88	74.5
Position	Clinic	114	96.6
	Hospital	4	3.3

characteristics. There were 70 dental hygienists (60.1%) and 48 non-dental hygienists(31.3%). 91(77.1%) were the most in their 20s and 30s, and 88(74.5%) were unmarried, 114(96.6%) were working at clinics whereas 4(3.3%) were working at hospitals due to the nature of dental work, the number of clinics was far superior (Table 1).

2. Equipment Status of Dentistry

The number of intraoral/ Extraoral cameras was the highest with 84 units(71.1%) and the digital radiographs were 102 with 86.4%. The largest number of digital

radiation protection equipment is 64(54.2%) of lead suits, followed by TLD badge>shooting with smaller exposure>thyroid guard>other respectively. The most frequently used were lead armor>TLD badge>thyroid protector>other respectively (Table 2).

3. Radiation Safety Management Training

31(44.3%) dental hygienist group had 'safe education' which was higher than non-dental hygiene groups (Table 3).

4. Carrying out training according to the type

Table 2. Equipment Status of Dentistry

Characteristics	Sort	Number	%
Radiation Unit	〈Intraoral camera〉		
	1 unit	84	71.1
	2 units	27	22.9
	3 units and more	6	5.1
	〈Extraoral camera〉		
	1unit	94	79.6
	2 units	14	11.9
	3 units and more	5	4.23
	〈Digital radiography〉		
Yes	102	86.4	
No	16	13.6	
Digital radiation protection equipment	Lead armor	64	54.2
	Thyroid Guard	9	7.6
	TLD badge	49	41.5
	Small exposure	30	25.4
	Others	6	5.1
	Radiation protection equipment	Lead wall(Shielding plate)	89
TLD badge		55	47.6
Lead armor		84	71.1
Thyroid Guard		12	10.1
Others		4	3.4

Table 3. Radiation Safety Management Training

(N(%))

		Dental Hygienist	Others	χ^2	p-value
Safety Training	Yes	31(44,3)	14(29,2)	1,138a	0,286
	No	39(55,7)	34(70,8)		
Total		70(59,3)	48(40,7)		

Table 4. Carrying out training according to the type of radiation safety management training

(N(%))

		Dental Hygienist	Others	χ^2	p-value
Self-education	Yes	14(35,9)	6(17,6)	1,138a	0,286
	No	25(64,1)	28(82,4)		
Refresher training	Yes	13(33,3)	4(11,8)	2,420a	0,120
	No	26(67,6)	30(88,2)		
School education	Yes	14(35,9)	3(9,8)	4,366a	0,037
	No	25(64,1)	31(91,2)		
Total		39(33,1)	34(29,8)		

of radiation safety management training

In the type of radiation safety management education, self-education was the highest among the dental hygienists' group: 14(35,9%) in the dental hygienist group and 6(17,6%) in the non-dental hygienist group. With the refresher training, there were 13 with dental hygienist groups(33,3%) and 4 with non-dental hygienist groups(11,8%), 14 dental hygienists(35,9%) were trained at a school whereas 3 non-dental hygienists (9,8%) <Table 4>.

If they were listed in order, the group of dental

hygienists was in order of self-education \geq school education > refresher training, and the groups other than dental hygienists were self-education > refresher training > school education.

5. Item-specific knowledge between occupations

The average of knowledge among occupations was higher in the dental hygienist group than in the non-dental hygienist group, and in questions no. 2, the non-dental hygienist group was higher than the dental hygienist group. The highest average in the

Table 5. Item-specific knowledge between occupations

Question	Dental Hygienist	Others	p-value
1. The intensity of the X-rays decreases over distance.	4,11±0,956	3,50±1,272	0,003*
2. Occupational doses should not exceed 20 mSv per year on average over the five years prescribed.	3,24±1,377	3,35±1,345	0,663
3. There are two types of radiation disorders: chronic and acute.	3,89±1,057	3,54±1,237	0,108
4. The gonads in the human body are very sensitive to radiation.	4,14±1,026	3,81±1,197	0,111
5. X-ray shielding is possible with materials made of lead or concrete.	4,06±1,075	3,50±1,399	0,016
6. Radiation exposure can have a genetic effect.	4,29±0,705	4,04±0,849	0,092
7. An X-ray irradiation switch is installed outside the shooting room.	4,37±0,920	4,31±0,854	0,722
8. According to the safety management rules, the head of the medical institution or the person in charge of safety management should ensure that the worker undergoes regular medical examination at least once a year.	4,36±0,660	4,27±0,664	0,481
9. Extraoral radiography has a higher radiation dose than intraoral radiography.	3,79±1,226	3,29±1,383	0,044*
10. The operator or patient should not hold the x-ray crown by hand while the x-ray is exposed.	4,13±1,020	3,06±1,390	<0,001*
11. Longer focal-film distances reduce skin exposure.	3,37±1,253	2,96±1,398	0,096
12. Individual exposure can be measured on TLD badges or film media.	4,01±0,955	3,29±1,398	0,001*

dental hygienist group was 7 questions and the lowest average was question no. 2 (Table 5).

6. Item attitudes between occupations

The average of attitudes among occupations was higher in the dental hygienist group than in the non-dental hygienist group, and in question no.3, the non-dental hygienist group was higher than the dental hygienist group. The highest average in the dental hygienist group was 10 questions, and the lowest average was questions no. 2 and 3. The highest

average of the non-dental hygienists' group was question no. 10 and the lowest average was question no. 4 (Table 6).

7. Item-specific behavior among employees

The average of the behaviors among occupations was higher in the dental hygienist group than in the non-dental hygienist groups and questions no. 2, 3, and 10 were higher in the non-dental hygienist group than in the dental hygienist group. The highest average in the dental hygienist group was questions

Table 6. Item attitudes between occupations

Question	Dental Hygienist	Others	p-value
1. Dose measurements should be made on a regular basis for dose correction of radiological devices.	4.30±0.688	4.17±0.595	0.265
2. Performance testing of radiation protection aprons should be made or received.	4.11±0.753	3.96±0.849	0.296
3. Radiation protection aprons should be stored so that they are not bent or folded.	4.11±0.894	4.13±0.672	0.941
4. Must wear a statutory dosimeter during work.	4.16±0.879	3.60±1.026	0.002*
5. It is a good idea to receive regular training on radiation safety management	4.16±0.810	3.85±0.799	0.047
6. Health check-ups should be regularly conducted in relation to radiation exposure.	4.40±0.689	4.23±0.751	0.205
7. During irradiation, work should be done behind the barrier (lead wall).	4.44±0.629	4.29±0.683	0.218
8. Irradiation should be kept at a reasonable distance from the radiologist	4.31±0.731	4.19±0.734	0.350
9. Children should use protective equipment to shield the gonads and thyroid gland during irradiation.	4.33±0.737	4.10±0.660	0.087
10. The women's menstrual cycle or pregnancy should be checked before irradiation.	4.54±0.652	4.33±0.742	0.104
11. The radiation should be shielded according to the menstrual cycle or pregnancy of the woman of childbearing age.	4.54±0.606	4.27±0.736	0.030*

Table 7. Item-specific behavior among employees

Question	Dental Hygienist	Others	p-value
1. Check the radiation-related equipment at work is in good working condition before use.	4.10±0.854	4.02±0.758	0.598
2. After using the radiation protection apron, straighten out and store it.	3.71±1.229	3.75±0.978	0.861
3. Perform or test performance of radiation protection aprons.	3.13±1.329	3.23±1.153	0.663
4. During radiation work, a regular statutory dosimeter is worn.	3.47±1.271	3.44±1.165	0.881
5. I check the doses of radiation that have been measured on a monthly or quarterly basis.	3.33±1.370	3.00±1.255	0.181
6. Receive regular training on radiation safety management.	3.07±1.386	3.07±1.386 2.77±1.259	0.224
7. Work behind a barrier during irradiation.	4.07±1.026	3.85±0.850	0.213
8. Irradiation should be kept at an appropriate distance from the source and the patient.	4.04±0.970	3.88±0.890	0.334
9. Protective equipment should be used to shield the gonads and thyroid gland during irradiation.	3.66±1.214	3.42±1.145	0.277
10. Check the menstrual cycle or pregnancy of the woman of childbearing age before irradiation.	4.16±1.058	4.17±0.808	0.956
11. When irradiating pregnant women, use protective equipment in addition to the imaging area.	4.23±1.132	3.90±1.115	0.117

no. 11 and the lowest average was question no. 6. The highest average of the non-dental hygienists' group was question no. 10 and the lowest average was question no. 6 (Table 7).

IV. Discussions

The contribution of radiation to modern medicine is enormous, but there were many reports in the field of dental diagnostic radiology on the potential risks and biological hazards [7-8]. Since long-term exposure had been reported to be a harmful stimulus to the radiation worker and the human body [9], dentists should be aware of the potential risks of dental radiography. For this reason, dental hygienists must have a clear knowledge of radiation, behavior and attitudes in order to prevent disorders caused by radiation exposure, and they should be equipped with radiation protection equipment and regularly trained in radiation safety management.

As a result of this study, the number of oral cavity cameras was the highest in the dental equipment, with 84(71.1%) holding just one unit, 6(5.1%) were holding more than three units. The most common possession of extraoral cameras was 94(79.6%) with one unit, and 5(4.23%) were in possession of more than 3 units. 102(86.4%) possessed a digital radiography camera and the most common radiation protection equipment was 64(54.2%) with lead armor and 6(5.1%) with others. Digital radiation protection equipment had the highest lead walls(shields) with 89(75.4%) and the lowest with 4(3.4%).

As the use of radiation in dental institutions is essential for the diagnosis and treatment of dental diseases, and its use is increasing and diversifying [10], the holding state of the latest equipment, digital radiography, is the highest and the lead wall is considered to be the most used equipment.

There were 31(44.3%) dental hygienists who had received radiation safety management education and 39(55.7%) who had never received it. In the non-dental hygienists' group, 14(29.2%) had received the radiation

safety management education and 34(70.8%) had never received it. In other words, the group of dental hygienists received more safety management training ($p=0.286$). Among the safety management education, 14(35.9%) had trained the self-education out of 39 dental hygienists whereas 6(17.6%) had experienced self-education in non-dental hygienists' groups ($p=0.268$). With the conservative education, among the 39 of dental hygienist groups, 13(33.3%) had trained it whereas among the 34 of non-dental hygienist groups, 4(11.8%) had the conservative education ($P=0.12$). School education showed 14(35.9%) out of 39 dental hygienist groups had experienced it whereas 3(9.8%) out of 34 non-dental hygienist groups had it ($p=0.037$).

In this study, more than 55% of dental workers received radiation safety training. However, 33% of all dental hygienists received safety management education in self-service, conservative education and school education. This is because most of the non-radiologists, non-majors, dental hygienists and professors are conducting radiation classes in Korea, and they are not well aware of radiation safety management [11]. Since there is no education on radiation safety management after graduating from school, all dental workers including dental hygienists need to supplement knowledge on radiation safety management from school curriculum which is believed that this is a necessary action. Also, the frequency of radiography in dental clinics In the increasing situation, the dental hygiene department and students should be given an awareness of the management of individual radiation exposure [12-14].

As a result of knowledge by question among occupations, the dental hygienist group had higher average than the non-dental hygienist group. The dental hygienist group was highest in the question 'X-ray irradiation switch should be installed outside the room', and the lowest with the question 'Occupational exposure dose should not exceed 20mSv per year on average for the prescribed 5 years'. The non-dental hygienist group had the highest question 'X-ray irradiation switch should be installed outside the room', and the lowest with the question 'The longer

the distance between the focus and the film, the lower the skin exposure was' ($P<0.05$).

The knowledge score of dental hygienists on radiation safety management was 9.71 in Lee [3], 9.71 in Kim [1], and 9.8 in Kim [11]. Kim et al. [11] found that the knowledge level on radiation safety management improved from 9.8 points before education to 12.9 after education, which has the effect of education on radiation safety management.

As a result of the attitudes among the occupations, the dental hygienist group had higher average than the non-dental hygienist group. The dental hygienist group had the highest average in the question of 'Must shield the radiation according to the menstrual cycle or pregnancy of the child of childbearing'. However, they showed the lowest average in the question of 'Must perform or undergo the performance test of the radiation protection apron' and 'It is good to keep the radiation protection apron from being bent or folded'. The non-dental hygienist group had the highest average in the question of 'Checking the menstrual cycle or pregnancy of childbearing women before radiation', and the lowest in the question was 'to wear a statutory dosimeter during work' ($P<0.05$). Kim et al. [11] found that education on radiation safety management improved the knowledge and attitudes of radiation on dental hygiene students through radiation safety management education.

As a result of item-specific behavior among employees, the group of dental hygienists was higher than the group other than dental hygienists. The dental hygienist group had the highest average of 'protective devices in addition to the imaging area when irradiating pregnant women', and the lowest average was 'trained regularly in radiation safety management'. The non-dental hygienist group showed the highest score on the question of 'checking the menstrual cycle or pregnancy of a woman of childbearing potential before radiation investigation', and the lowest score on the question 'trained regularly on the radiation safety management' ($p<0.05$). As demonstrated by Jeon et al. [15], knowledge, attitudes and behaviors of radiation safety management were all correlated.

Taken together, these results indicate that the dental hygienist group is more concerned about radiation safety and that the dental hygienist group is receiving more radiation safety management training. However, if there is a low level of 'has experienced' in the presence or absence of safety management education, it is difficult to train radiation safety management in dentistry. Therefore, it is considered that dentists should be trained in radiation safety management periodically to pay attention to radiation safety accidents. If there is a low level of 'has completed training/education' in the presence or absence of safety management education, it is difficult to train radiation safety management in dentistry. The shorter the dental hygienist and radiography experiences, the lower the level of behavior so that it is necessary to make policy to receive compulsory education on radiation safety management before entering into clinical practice [2]. Dental workers should be trained in radiation safety management periodically to pay attention to radiation safety.

V. Conclusions

The study surveyed 118 dental workers working in dental hospitals and clinics in Busan area were surveyed from November 2nd to November 14th, 2019 to compare the differences in attitudes, knowledge, and behaviors among dental workers.

1. Radiation safety education has 39 dental hygienists who had more education than non-dental hygienists ($p=0.286$).
2. The most common types of radiation safety education were self-education which usually performed by dentistry, followed by conservative education and others.
3. The average of radiation attitudes, knowledge and behaviors was higher in the dental hygienist group than in the non-dental hygienist group.
4. On the item-specific behavior among employees, the question of 'the radiation should be shielded according to the menstrual cycle or pregnancy of the

woman of childbearing' was significant ($p < 0.05$).

5. On the item-specific knowledge between occupations, the question of 'the intensity of X-rays decreases over distance' and 'the individual exposure can be measured by TLD badge or film badge' was significant ($p < 0.05$)

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