

# Radiography Work Performed by Dental Hygienists according to the Workplace Type

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**Background:** Dental hygienists study dental radiology through the dental hygiene department and curriculum, and most of the radiography work in dental clinics is performed by dental hygienists; however, the legal work regulations for dental hygienists place restrictions on the type of radiography performed. This study aimed to identify the actual conditions of the radiographic work performed by dental hygienists and to determine the difference according to the type of hospital.

**Methods:** This study included 195 dental hygienists working at dental medical institutions in the metropolitan area. A survey was conducted on regarding the radiographic work performed and the clinical career of the main performers. The radiography work was divided into periapical radiography, bite-wing radiography, occlusal radiography, panoramic radiography, computed tomography (CT), and cephalometric radiography.

**Results:** The frequency of performing intraoral radiography was as follows: periapical radiography, 94.9%; bite-wing radiography, 93.8%; and occlusal radiography, 77.9%. The frequency of performing extraoral radiography was 94.4% for panoramic radiography, 89.7% for CT, and 73.3% for cephalometric radiography. The frequency of internal and external radiography performance was higher among hygienists in dental clinics than among those in dental hospitals and university hospitals. The analysis of the dental hygienists' clinical experience in the areas of intraoral and extraoral radiography showed that those working at university hospitals, dental hospitals, and dental clinics had over 5 years, 2~4 years, and 1 year of clinical experience, respectively. The hygienists with less than 1 year of clinical experience showed high performance frequency ( $p < 0.05$ ).

**Conclusion:** For the dental hygienists to perform radiography safely, a discussion regarding the revision of related laws and regulations is warranted.

**Key Words:** Dental clinic, Dental hygienist, Dental radiography

## Introduction

Radiographic examinations during dental treatment, along with clinical examinations, are performed as essential processes for diagnosis of oral diseases and establishment of treatment plan, while radiographs are used to check the anatomical structure, conditions of the periodontal tissues, and dental calculus or excess restoration<sup>1</sup>. Dental radiography can be divided into intraoral and extraoral radiography depending on the film position. Intraoral radiography includes standard, bite-wing, and occlusal radiography,

while extraoral radiography includes panoramic radiography, cephalometric radiography, and computed tomography (CT)<sup>2</sup>.

As of 2019, the number of dental radiography cases accounted for 11.1% of all medical radiography cases claimed to the Health Insurance Review and Assessment Service (HIRA), of which, intraoral radiography accounted for the most with 59.5%, followed in order by panoramic radiography (38.3%), CT (2.1%), and cephalometric radiography (0.1%)<sup>3</sup>. However, radiography for implants or orthodontic treatment is considered a non-covered

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procedure that would not be claimed to HIRA, and thus, the number of dental radiography cases are expected to be significantly higher than those reported<sup>3)</sup>.

In dental clinics, dental radiography may be performed by a dentist or dental hygienist under the supervision of a dentist and a radiographer. Except, only intraoral diagnostic radiography is included within the legal work scope of dental hygienists<sup>4)</sup>. Among extraoral radiography, since the purpose of panoramic radiography for imaging intraoral lesions, it was recognized as a part of the legal work scope of dental hygienists according to the administrative interpretation by the Ministry of Health and Welfare on March 19, 2009, whereas cephalometric radiography and CT have been excluded from the legal work scope of dental hygienists<sup>5)</sup>.

Dental hygienists complete courses on dental radiology (oral radiology) through the dental hygiene (major) curriculum and they receive theoretical and practical training on each imaging technique to acquire competency to perform intraoral and extraoral radiographic imaging<sup>6,7)</sup>. Most dental hygienists who have competency in radiography work perform radiographic imaging in clinical practice<sup>8)</sup>, but because there are limitations on types of radiographic imaging dental hygienists can legally perform, this is an aspect that needs improvement.

To safely perform radiographic imaging on patients in dental clinics, discussions are needed on improving the legal work scope of dental hygienists regarding radiographic imaging, for which, there is the need to investigate the actual performance of radiography work by dental hygienist. A study report from 2004 mentioned that performance of extraoral radiography work by dental hygienists was 92.0%<sup>9)</sup>, but there is a lack of studies that have identified the radiography work among dental hygienists in recent years.

Up to now, most of the studies on radiography work among dental hygienists have focused mostly on radiation safety management<sup>10-13)</sup>. While few studies have reported on the status of use of dental radiographic equipment<sup>14,15)</sup> it is difficult to find studies that have focused on radiography work of dental hygienists.

Accordingly, the present study aimed to identify the performance of intraoral and extraoral radiography work

performed by dental hygienists in clinical practice and to identify the performance rate of radiography work according to type of workplace.

## Materials and Methods

### 1. Participants

A questionnaire survey was conducted between June 2019 and February 2020 on 250 dental hygienists working in dental clinics. Based on 2019 Year Book of the Korean Dentistry<sup>16)</sup> reporting that approximately 50% of dental hygienists work in dental clinics located in Seoul capital region, the study population was set to dental hygienists working in dental clinics located in Seoul capital region. A total of 220 sets of questionnaires were returned, and after excluded 25 sets with insincere responses, a total of 195 sets were included in the final analysis.

The sample size was calculated using G\*Power 3.1 program with effect size of 0.3, significance level of 0.05, explanatory power of 95%, and degree of freedom of 3. The results showed that the minimum sample size needed for chi-squared test is 191. This study was conducted with the subject's written consent.

### 2. Survey tool

The present study used a job survey questionnaire by referencing "2nd job analysis for dental hygienists"<sup>17)</sup> and "A study on the dentist's opinion on the actual work and legal work of dental hygienists"<sup>18)</sup> by the Korean Dental Hygienists Association (KDHA).

In accordance with the objective of the study, general characteristics (sex, clinical experience, type of workplace, and work department), performance of different types of radiography work, and clinical experience for work usually performed by different types of radiography work. Type of workplace was divided in dental clinic, dental hospital, and university dental hospital. Radiography work was divided into six categories, including three intraoral radiography (apical, bite-wing, and occlusal radiography) and three extraoral radiography (panoramic radiography, CT, and cephalometric radiography). The clinical experience of dental hygienists in work they usually performed was investigated to identify the performance of radiography

work according to clinical experience of dental hygienists. For the analysis, clinical experience was divided into  $\leq 1$ ,  $2 \sim 4$ , and  $\geq 5$  years, while response of “I don’t perform the work now but may perform it in the future” was classified as “may perform in the future.”

**Table 1.** General Characteristics

Classification		Value
Sex	Male	6 (3.1)
	Female	189 (96.9)
Work experience (y)	$\leq 1$	31 (15.9)
	$2 \sim 4$	74 (37.9)
	$\geq 5$	90 (46.2)
Hospital type	University hospital	31 (15.9)
	Dental hospital	89 (45.6)
	Dental clinic	75 (38.5)
Work department	Prosthodontics, endodontics	44 (22.6)
	Advanced general dentistry	41 (21.0)
	Dental orthodontics	31 (15.9)
	Oral and maxillofacial surgery	28 (14.3)
	Periodontics	20 (10.2)
	Pediatric dentistry	10 (5.1)
	Oral medicine	5 (2.6)
Others	16 (8.2)	
Total		195 (100.0)

Values are presented as number (%).

### 3. Analysis method

Statistical Package for the Social Science (SPSS) WIN 25.0 program (IBM Corp., Armonk, NY, USA) was used for analysis. Frequency analysis was performed to identify the general characteristics of the participants and performance rate of radiography work according to type of workplace, while chi-squared test was performed to identify the differences in performance of radiography work according to the clinical experience of dental hygienists. The statistical significance level was set to 0.05.

## Results

### 1. General characteristics

The general characteristics of the participants were as shown in Table 1. Among the participants, 96.9% were females, while  $\geq 5$  years was the most common response for work experience with 46.2%. Type of workplace appeared in the order of dental hospital (45.6%), dental clinic (38.5%), and university dental hospital (15.9%).

### 2. Performance of radiography work according to type of workplace

Performance of radiography work according to type of workplace was as shown in Table 2. Among intraoral radiography work, performance of apical radiography was 94.9%, which was relatively higher than that of bite-wing

**Table 2.** Radiography Work Performed by Type of Workplace

Classification			Total	University hospital	Dental hospital	Dental clinic
Intraoral radiography	Periapical radiography	Yes	185 (94.9)	24 (77.4)	86 (96.6)	75 (100.0)
		No	10 (5.1)	7 (22.6)	3 (3.4)	-
	Bite-wing radiography	Yes	183 (93.8)	24 (77.4)	86 (96.6)	73 (97.3)
		No	12 (6.2)	7 (22.6)	3 (3.4)	2 (2.7)
Extraoral radiography	Occlusal radiography	Yes	152 (77.9)	22 (71.0)	60 (67.4)	70 (93.3)
		No	43 (22.1)	9 (29.0)	29 (32.6)	5 (6.7)
	Panoramic radiograph	Yes	184 (94.4)	24 (77.4)	85 (95.5)	75 (100.0)
		No	11 (5.6)	7 (22.6)	4 (4.5)	-
Computed tomography	Cephalometric radiograph	Yes	143 (73.3)	20 (64.5)	53 (59.6)	70 (93.3)
		No	52 (26.7)	11 (35.5)	36 (40.4)	5 (6.7)
	Computed tomography	Yes	175 (89.7)	20 (64.5)	84 (94.4)	71 (94.7)
		No	20 (10.3)	11 (35.5)	5 (5.6)	4 (5.3)
Total		195 (100.0)	31 (15.9)	89 (45.6)	75 (38.5)	

Values are presented as number (%).

radiography (93.8%) and occlusal radiography (77.9%). Among extraoral radiography, performance appeared in the order of panoramic radiography (94.4%), CT (89.7%), and cephalometric radiography (73.3%).

With respect to performance of radiography work according to type of workplace, performance of intraoral and extraoral radiography work was higher in those who work in dental clinic than those in dental hospital and university dental hospital.

### 3. Performance of radiography work according to clinical experience of dental hygienists by type of workplace

Performance of radiography work according to clinical experience of dental hygienists by type of workplace was as shown in Table 3. For all types of intraoral radiography work, performance rate was highest among those with clinical experience of  $\geq 5$  years in university dental hospitals, 2~4 years in dental hospitals, and  $\leq 1$  year in dental clinics, and the differences were statistically significant ( $p < 0.05$ ).

For cephalometric radiography and CT, performance rate was highest among those with clinical experience of

**Table 3.** Radiography Work according to Clinical Experience

Classification			University hospital	Dental hospital	Dental clinic	p-value		
Intraoral radiography	Periapical radiography (y)	$\leq 1$	7 (22.6)	27 (30.3)	36 (48.0)	< 0.001		
		2~4	5 (16.1)	32 (36.0)	24 (32.0)			
		$\geq 5$	12 (38.7)	27 (30.3)	15 (20.0)			
		Likely to perform in the future	7 (22.6)	3 (3.4)	-			
	Bite-wing radiography (y)	$\leq 1$	6 (19.4)	27 (30.3)	30 (40.0)		< 0.001	
		2~4	6 (19.4)	32 (36.0)	28 (37.3)			
		$\geq 5$	12 (38.7)	27 (30.3)	15 (20.0)			
		Likely to perform in the future	7 (22.6)	3 (3.4)	2 (2.7)			
	Occlusal radiography (y)	$\leq 1$	6 (19.4)	14 (15.7)	28 (37.3)			< 0.001
		2~4	6 (19.4)	25 (28.1)	28 (37.3)			
		$\geq 5$	10 (32.3)	21 (23.6)	14 (18.7)			
		Likely to perform in the future	9 (29.0)	29 (32.6)	5 (6.7)			
Extraoral radiography	Panoramic radiograph (y)	$\leq 1$	6 (19.4)	28 (31.5)	37 (49.3)	< 0.001		
		2~4	6 (19.4)	31 (34.8)	23 (30.7)			
		$\geq 5$	12 (38.7)	26 (29.2)	15 (20.0)			
		Likely to perform in the future	7 (22.6)	4 (4.5)	-			
	Cephalometric radiograph (y)	$\leq 1$	6 (19.4)	10 (11.2)	28 (37.3)		< 0.001	
		2~4	5 (16.1)	23 (25.8)	28 (37.3)			
		$\geq 5$	9 (29.0)	20 (22.5)	14 (18.7)			
		Likely to perform in the future	11 (35.5)	36 (40.4)	5 (6.7)			
	Computed tomography (y)	$\leq 1$	6 (19.4)	25 (28.1)	32 (42.7)			< 0.001
		2~4	4 (12.9)	33 (37.1)	25 (33.3)			
		$\geq 5$	10 (32.3)	26 (29.2)	14 (18.7)			
		Likely to perform in the future	11 (35.5)	5 (5.6)	4 (5.3)			
Total			31 (15.9)	89 (45.6)	75 (38.5)			

Values are presented as number (%).

$\geq 5$  years in university dental hospitals, 2~4 years in dental hospitals, and  $\leq 1$  year in dental clinics, which indicated that performance rate was higher among dental hygienists with longer clinical experience as the size of workplace increased.

## Discussion

The present study was conducted to identify performance of radiography work by dental hygienists. The findings showed that the type of intraoral radiography performed appeared in the order of apical radiography (94.9%), bite-wing radiography (93.8%), and occlusal radiography (77.9%), while the type of extraoral radiography performed appeared in the order of panoramic radiography (94.4%), CT (89.7%), and cephalometric radiography (73.3%; Table 2). Such results were similar to performance rate of 96.2% for intraoral radiography, 96.6% for panoramic radiography, 80.1% for CT, and 69.3% for cephalometric radiography reported in a report published by KDHA in 2020<sup>19)</sup>, which can be interpreted as that most of intraoral and extraoral radiography work is performed by dental hygienists in clinical practice.

According to the Medical Service Technologist Act, duties of dental hygienists are defined as “removal of deposits such as dental calculus; fluoride appliance; temporary filling; temporary attachment application and removal; impression taking; ligation and removal of orthodontic wire; intraoral diagnostic radiography performed in health or medical institutions; and other work related to preventing dental and oral diseases and dental hygiene control”<sup>4)</sup>. Due to the limited legal work scope of dental hygienists, dental hygienists face risk of legal repercussions if they perform CT and cephalometric radiography as instructed by a dentist or as clinical practice.

In clinical practice, radiography work is performed mostly by dental hygienists for efficiency of patient care<sup>20)</sup>, and in particular, dental institutions with no radiographer on duty are believed to have dental hygienist perform intraoral radiography, as well as CT and cephalometric radiography, as common practice. In the present study, the results on performance of radiography according to type of workplace showed that performance

rate was relatively higher among workers in dental clinics than those in dental hospitals and university dental hospitals. Meanwhile, performance of cephalometric radiography was 93.3% in dental clinics, whereas dental hospitals and university dental hospitals showed a large difference with 59.6% and 64.5%, respectively (Table 2). A study by Kim et al.<sup>21)</sup> also reported that performance of cephalometric radiography by dental hygienists was 83.9% in dental clinics and 69.5% in dental hospitals, which were similar to the findings in the present study. This could be due to the difference in the number of radiographers assigned depending on the scale of dental institutions. According to the 2020 Year Book of Korean Dentistry<sup>22)</sup>, the number of radiographers working in 18,496 dental institutions (235 dental hospitals and 18,261 dental clinics) was 87 in dental hospitals and 26 in dental clinics. When number of radiographers by type of dental institution is calculated based on such report, the results showed one radiographer per 2.7 dental hospitals and 702.3 dental clinics. Consequently, dental hygienists would actually be responsible for dental radiography work, regardless of legal work regulations, and in particular, dental hygienists are more likely to perform radiography work outside the legal work scope in dental institutions with smaller scale. Since the present study did not investigate the number of radiographers at each type of workplace, future studies should identify the association with this factor.

Previous studies have also claimed that improvement is needed on the restrictions in the legal work scope of dental hygienists. A study by Kim et al.<sup>21)</sup> investigated dental hygienists and dentists for their thoughts on whether it would be appropriate to recognize CT and cephalometric radiography should be recognized as a part of the legal work scope of dental hygienists. The results showed that 93.7% dental hygienists and 79.5% of dentists agreed that CT should be recognized, while 95.1% of dental hygienists and 87.2% of dentists agreed that cephalometric radiography should be recognized. A study by Han et al.<sup>23)</sup> also reported that 60.0% of dentists believed that the scope of radiography needs to be expanded. Dental hygienists performing their roles within the legal work scope is an important factor with respect to safety management of

dental patients, and thus, legal improvement must take place to reflect the reality of clinical practice. Moreover, the regulations for radiography work performed by dental hygienists, which is currently subdivided, should be revised to be more comprehensive through discussions among relevant organization for improvement to enable dental hygienists to safely perform radiography-related work. Dental hygienists with clinical experience of at least three years can be designated as a safety manager for dental diagnostic radiography, and designated safety managers must manage and supervise all aspects of radiation safety management system, including radiation equipment management and employee radiation exposure management, after completing relevant training<sup>24</sup>). Currently, dental hygienists are mostly responsible as safety management duties for diagnostic radiography in dental institutions, but awareness of radiation safety management system has been reported to be somewhat lacking<sup>25</sup>), and thus, educational program for dental radiation safety management must be provided and standardized safety management guidelines need to be prepared<sup>25,26</sup>).

In the present study, investigation of performance of radiography according to clinical experience of dental hygienists showed that the performance rate was high among dental hygienists with clinical experience of  $\geq 5$  years in university dental hospitals, 2~4 years in dental hospitals, and  $\leq 1$  year in dental clinics for both intraoral and extraoral radiography work ( $p < 0.05$ ; Table 3). Different studies have reported different results on work performance according to clinical experience of dental hygienist. In a study by Kwon and Lee<sup>27</sup>), the frequency of care assistance work, including dental radiography, was highest among mid-level managers or above. In addition, a study by Ahn et al.<sup>28</sup>) reported that most clinical treatment work is concentrated among those with  $\leq 4$  years of experience. High performance rate among those with  $\leq 4$  years of experience at dental clinics, dental hospitals, and university dental hospitals found in the present study is partially consistent with the results in the study by Ahn et al.<sup>28</sup>). However, the findings showed that radiography work is somewhat concentrated among those with  $\leq 1$  year of experience in dental clinics. It is believed that this is due to small-scale dental clinics not having detailed

employee ranking system<sup>29</sup>), and as a result, care assistance work is delegated and being performed regardless of tenure.

Because the study population in the present study included only some dental hygienists from the Seoul capital region, there are limitations in generalizing the findings. While work environment related to radiography work may vary depending on the work type, this aspect was not investigated and any association could not be identified. Accordingly, it is necessary for future studies to target all dental hygienists throughout Korea to investigate variables associated with radiography work.

The present study investigated performance of radiography work among dental hygienists and found that performance of CT and cephalometric radiography, which are excluded in the legal work scope of dental hygienists, were being performed at a high rate among dental hygienists. Accordingly, legal regulations regarding radiography work among dental hygienists should be improved based on the findings in the present study, for which, discussions among relevant organization will also be needed.

## Notes

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

### Ethical approval

The study was approved by the Institutional Review Board of Shinhan University (IRB No. SHIRB-201904-HR-089-02).

### Author contributions

Conceptualization: Mi-Sook Yoon. Data acquisition: Mi-Sook Yoon. Formal analysis: Mi-Sook Yoon. Supervision: Mi-Sook Yoon. Writing-original draft: Mi-Sook Yoon and Bo-Young Park. Writing-review & editing: Mi-Sook Yoon and Bo-Young Park.

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