Original Article

Int J Oral Biol 46:168-175, 2021
pISSN: 1226-7155 • eISSN: 2287-6618
https://doi.org/10.11620/IJOB.2021.46.4.168

International Journal of Oral Biology
IJOB
Check for updates

Perceptions and attitudes of dental hygienists toward radiation safety and protection in the Republic of Korea

Kwidug Yun[1†], Kyung-Min Lee[2†], Seo-Young An[3], Suk-Ja Yoon[4], Ho-Gul Jeong[5]*, and Jae-Seo Lee[4]*

[1]*Department of Prosthodontic, School of Dentistry, Chonnam National University, Gwangju 61186, Republic of Korea*
[2]*Department of Orthodontics, School of Dentistry, Chonnam National University, Gwangju 61186, Republic of Korea*
[3]*Department of Oral and Maxillofacial Radiology, School of Dentistry, Kyungpook National University, Daegu 41940, Republic of Korea*
[4]*Department of Oral and Maxillofacial Radiology, School of Dentistry, Dental Science Research Institute, Chonnam National University, Gwangju 61186, Republic of Korea*
[5]*InvisonLab Inc., Seoul 05854, Republic of Korea*

To investigate the perceptions and attitudes of dental hygienists toward radiation safety management in Korea. A total of 800 dental hygienists were randomly selected for an anonymous survey, and 203 of them participated. The questionnaire items included the following: sex, career period, type of installed radiographic equipment, recognition of the diagnostic reference level (DRL), participation in radiation safety education, and attitudes toward radiation protection for both patients and dental hygienists. The participants were divided into two groups according to their years of experience (< 10 years versus ≥ 10 years). The difference between the groups was investigated according to frequency distribution. Fisher's exact test or Pearson's chi-square (χ^2) test was used as appropriate. A regression analysis was performed to investigate the impact of wearing a thyroid collar for personnel protection during patient radiation exposure. The types of installed radiographic equipment included panoramic radiography (96.1%), cephalometric radiography (76.9%), intraoral radiography (72.9%), and cone-beam computed tomography (69.5%). Significant differences were observed in the learning pathway for the DRL (Fisher's exact test, $p < 0.05$), satisfaction with radiation safety education (Pearson's χ^2 test = 5.3975, Pr = 0.02), and use of personnel radiation monitoring systems (Pearson's χ^2 test = 18.1233, Pr = 0.000) between the groups. Significant differences were also observed in personnel protection using a thyroid collar and patient protection during panoramic radiography (odds ratio = 14.2). Dental hygienists with more than 10 years of experience were more satisfied with radiation safety education and more interested in radiation monitoring. Considering career experience, customized, continuous, and effective radiation safety management education should be provided.

Keywords: Radiation protection, Radiography, Dental

Introduction

Dentists, radiologic technologists, or dental hygienists are responsible for radiation safety management in dental clinics. In previous studies, radiologic technologists have been reported to be more aware of radiation safety management before and

Received November 22, 2021; **Accepted** November 30, 2021
***Correspondence to:** Ho-Gul Jeong, E-mail: rari98@naver.com https://orcid.org/0000-0002-3322-8453
***Correspondence to:** Jae-Seo Lee, E-mail: jsyi16@jnu.ac.kr https://orcid.org/0000-0001-8059-0378
[†]Kwidug Yun and Kyung-Min Lee contributed equally to this work.

after radiation safety management training than other professionals; meanwhile, dentists and dental hygienists have been reported to be less aware of radiation safety management before receiving radiation safety training [1]. Recent studies have reported on the radiation safety management protocols and attitudes of dentists in South Korea [2–5]; however, only a few studies have investigated radiation safety management among dental hygienists nationwide.

Dental hygienists are in charge of obtaining dental radiographs, in addition to dental treatment assistance and oral health education. Although the amount of radiation exposure, owing to radiography, for dental hygienists is insignificant, dental radiographs account for 11% of all medical radiographs obtained therein [6,7]; thus, radiation safety management is also important in dental clinics. According to the statistical data from the Health Insurance Review and Assessment Service, the number of panoramic radiographs obtained is increasing annually [6]. From 2015 to 2019, the number of panoramic radiographs and cone-beam computed tomography (CBCT) images obtained has increased by approximately 1.5 times and 2.3 times, respectively in Korea [6].

The radiographic equipment used in dental clinics includes equipment for intra-oral radiography, panoramic radiography, cephalometric radiography, and CBCT. Among the CBCT machines installed in all domestic medical institutions in South Korea, 89% are used in dental clinics [8]. Research on radiation safety management among dental hygienists in Korea is limited to a specific province or intra-oral radiographic equipment [7,9]. Furthermore, even in studies on two provinces, the evaluation of the attitude towards radiation safety management is limited to the use of portable intra-oral radiographic machines [10]. The purpose of this study was to investigate the knowledge of dental hygienists in South Korea on radiation safety.

Materials and Methods

As a serial study of our previous research [2], this study randomly selected 800 dental hygienists who were registered with the Korean Dental Hygienists Association. A priori sample size calculation was based on the previous study [2] using the G*Power program (v. 3.1.9.2; Department of Experimental Psychology, Heinrich-Heine-University, Dusseldorf, Germany) [11] 3.562; type I alpha risk, 0.05; and power, 95% indicated that a sample of 197 respondents was required. Thus, we sent our survey to 800 dental hygienists who were registered with the Korean Dental Hygienists Association considering the 25% of response rate.

Owing to the nature of this study, it was granted an exemption in writing by the Institutional Review Board of Chonnam National University Dental Hospital.

The questionnaire (Appendix) was distributed through e-mail/fax or through direct face-to-face interview; in 2017, it was answered by a total of 203 dental hygienists. The areas where these dental hygienists worked included Seoul and six metropolitan cities and four provinces in the Republic of Korea. Of them, 124 (61.1%) worked in the metropolitan cities and 79 (39.9%) in the provinces.

The questionnaire was filled out anonymously, and the questionnaire items included the following: sex, career period, type of installed radiographic equipment, recognition of the diagnostic reference level (DRL), participation in radiation safety education, and attitudes towards radiation protection for both patients and themselves.

Statistical analyses were performed using SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA). The data were evaluated according to frequency distribution, and Fisher's exact test and the Pearson's chi-square (χ^2) test were used to investigate the differences between the dental hygienists with < 10 years and ≥ 10 years of experience. A regression analysis was performed to compare the impact of wearing a thyroid collar for personnel protection on patient radiation protection.

Results

1. Years of career experience

All 203 dental hygienists were females; of them, 137 (67.5%) had < 10 years of experience, and 66 (32.5%) had ≥ 10 years of experience.

2. Installed radiographic equipment

Most of the panoramic and cephalometric radiographic equipment were digital equipment. The types of installed radiographic equipment in dental clinics were equipment for panoramic radiography (n = 196; 96.5%), intra-oral radiography (n = 169; 83.2%), cephalometric radiography (n = 156; 76.9%), and CBCT (n = 141; 69.5%; Table 1).

3. Recognition of the DRL

Of the respondents, 124 dental hygienists (61.1%) knew

the meaning of the DRL, while 79 (38.9%) did not (Table 2). There was no significant difference found in the recognition of the definition of the DRL between the two groups (Fisher's exact test, p = 0.005). However, a significant difference was observed in the learning pathway for the DRL between them (Fisher's exact test, p = 0.005).

Table 1. Installed radiographic machines in dental clinics in South Korea

Radiographic equipment	Dental hygienist (n = 203)
Intra-oral radiographic machine	
Digital	148 (72.9)
Film	21 (10.3)
Do not use	34 (16.7)
Panoramic radiographic machine	
Digital	195 (96.1)
Film	1 (0.5)
Do not use	7 (3.4)
Cephalometric radiographic machine	
Digital	156 (76.8)
Film	0
Do not use	47 (23.2)
Cone-beam computed tomographic machine	
Use	141 (69.5)
Do not use	62 (30.5)

Values are presented as number (%).

Table 2. Knowledge on the DRL according to career experience

Knowledge of DRLs	Dental hygienist		p-value
	Career experience of < 10 years	Career experience of ≥ 10 years	
Knowledge on the DRL			0.079
Yes	77 (56.6)	47 (70.1)	
No	59 (43.4)	20 (29.9)	
Total	136 (100)	67 (100)	
DRL learning pathway			0.005*
Approved radiation protection program	48 (62.3)	27 (57.4)	
School education	21 (27.3)	6 (12.8)	
Radiation safety officer	5 (6.5)	12 (25.5)	
Others	3 (3.9)	2 (4.3)	
Total	77 (100)	47 (100)	

Values are presented as number (%).
DRL, diagnostic reference level.
*p < 0.05.

4. Satisfaction with the approved radiation safety program

Of the 176 dental hygienists who received radiation safety training, 108 (61.4%) answered that the radiation safety education program helped them in managing the radiographic

Table 3. Satisfaction with the approved radiation safety program according to career experience

Radiation safety program	Dental hygienist		p-value
	Career experience of < 10 years	Career experience of ≥ 10 years	
Satisfaction with the radiation safety program			0.020*
Yes	66 (55.5)	42 (73.7)	
No	53 (44.5)	15 (26.3)	
Total	119 (100)	57 (100)	

Values are presented as number (%).
*p < 0.05.

Table 4. Use of protective aprons or thyroid collars and personnel monitoring device according to career experience

Patient and personnel radiation protection	Dental hygienist		p-value
	Career experience of < 10 years	Career experience of ≥ 10 years	
Use of protective aprons or thyroid collars (patient protection)			0.106
Cone-beam computed tomography	101 (73.7)	39 (59.1)	
Every dental radiographic procedure	14 (10.2)	9 (13.6)	
Panoramic radiography	7 (5.1)	6 (9.1)	
Periapical radiography	6 (4.4)	6 (9.1)	
Cephalometric radiography	6 (4.4)	1 (1.5)	
On patient's request	3 (2.2)	5 (7.6)	
Total	137 (100)	66 (100)	
Personnel monitoring device			< 0.001*
Use	44 (32.1)	42 (63.6)	
No use	93 (67.9)	24 (36.4)	
Total	137 (100)	66 (100)	
Use of thyroid collars (personnel protection)			> 0.99
Use	9 (7.0)	5 (7.7)	
No use	119 (93.0)	60 (92.3)	
Total	128 (100)	65 (100)	

Values are presented as number (%).
*p < 0.05.

Table 5. Relationship between personnel protection and patient protection

Use of thyroid collars (personnel protection)	Odds ratio	Standard error	$p > z$	95% CI
Periapical: Use of protective aprons (patient protection)	1.380923	1.060084	0.674	0.306713–6.217
Panoramic: Use of protective aprons (patient protection)	14.24018	10.84308	0	3.201653–63.336
Cephalometric: Use of protective aprons (patient protection)	0.395638	0.629299	0.56	0.017514–8.937
CBCT: Use of protective aprons (patient protection)	1.706448	2.590029	0.725	0.087126–33.422

CI, confidence interval; CBCT, cone-beam computed tomography.

machines or explaining radiation safety to patients. There was a significant difference found in the satisfaction with the approved radiation safety program between the groups (Pearson's χ^2 test = 5.3975, Pr = 0.02) (Table 3).

5. Use of radiographic examination and radiation protection procedures

When obtaining intra-oral radiographs of adult patients, 177 dental hygienists (87.1%) used bisecting techniques, and 26 (12.8%) used paralleling techniques.

The use of protective aprons or thyroid collars and personnel monitoring device according to career experience is shown in Table 4. There was no significant difference found in the use of protective aprons or thyroid collars for patient and personnel protection between the groups (Fisher's exact test, $p = 0.106$). However, there was a significant difference observed in the use of personnel monitoring device between them (Pearson's χ^2 test = 18.1233, pr = 0.000) (Table 4).

When directly holding a film or sensor for intra-oral radiography, 14 dental hygienists (7.2%) wore a thyroid collar, while 179 (88.1%) did not. Ten dental hygienists did not answer to this question. The reasons why the dental hygienists did not wear a thyroid collar were as follows: usage considered cumbersome and lack of available time (83.9%), lack of a protective thyroid collar (7.5%), amount of exposure considered small (3.7%), and non-usage of a thyroid collar in patients (3.1%).

A regression analysis was performed to compare the impact of wearing a thyroid collar for personnel protection on patient radiation protection (Table 5). There was a significant difference observed in the use of a thyroid collar for personnel protection and patient protection during panoramic radiography (odds ratio = 14.2).

Discussion

According to the distribution of diagnostic radiation generators announced by the Korea Disease Control and Preventive Agency in 2019 [12], radiographic equipment for dental clinics accounted for 16% (14,015 units) of the diagnostic radiation generators (89,955 units) in all medical institutions in Korea. Panoramic radiographic equipment accounted for 10% (8,722 units), and dental CBCT equipment accounted for 13% (11,825 units). Considering that medical computed tomography equipment accounted for 3% (2,390 units) of all diagnostic radiographic machines, it is important to manage radiation safety of dental CBCT.

The average duration of the use of diagnostic radiographic machines was reported to be 8.8 years, while that of dental radiographic machines was 11.2 years [13]. Therefore, there is a need to continuously improve the dental radiation safety management of radiographic machines with a long average usage period by setting and supplying the DRL for each type of dental radiographic equipment [13].

The DRL was introduced by the International Commision on Radiological Protection in 1990 [14]. It is a level used in medical imaging to promote optimization, which is derived from the third quartile value of distribution. Its use is a part of the overall process of optimization. Establishing and continuously applying the DRL in medical institutions through monitoring of the radiation dose of patients can help reduce their radiation exposure [15]. However, 38.9% of the dental hygienists in this study did not know the definition of the DRL (Table 2).

In this study, several types of digital radiographic equipment were installed. As radiographic equipment has been digitalized, the radiation dose is displayed on the dental panoramic radiograph and dental CBCT image. Therefore, it has become easier to apply the DRL in a dental clinic. Knowing the definition of the DRL and applying it in actual dental clinics will help reduce patient radiation exposure. As approximately 60% of the dental hygienists in this study became aware of the DRL through approved radiation safety management training (Table 2), it will be necessary to involve dental hygienists in approved radiation safety management training programs. In a previous study [1], customized radiation safety education for each dentist, radiologic technologists, and dental hygienist was conducted on a pilot basis, and there was an improved level of awareness on

radiation safety management in all occupations after education. Thus, it is recommended to provide customized radiation protection and safety management education to dental patients and dental radiation workers.

ICRP report of Publication 60 [14], the limits of exposure doses for radiation workers were stipulated as 50 mSv/year and 100 mSv/5 years, and Korea's diagnostic radiation safety management regulations comply with them. In 2019, the average value of the individual exposure doses of radiation workers in Korea was 0.45 mSv/year [16]. The average dose among radiation workers in South Korea is higher than 0.066 mSv in the UK (diagnostic radiation field, n = 10,604) [17], 0.05 mSv in Germany (n = 286,855) [18], 0.07 mSv in Canada (diagnostic radiation field, n = 105,274) [19], and 0.30 mSv in Japan (n = 397,720) [20]. The average annual exposure dose of dentists and dental hygienists is 0.18 mSv and 0.15 mSv in South Korea, respectively [16]. The average annual exposure dose of dental radiation workers is lower than that of other radiation workers in domestic medical institutions. However, the average annual exposure dose of dental radiation workers in South Korea is higher than that of dental radiation workers in the UK (0.0068 mSv; n = 1,808 in 2016) [17]. Therefore, there is a need to strengthen radiation safety management.

In this study, we found that patients did not always wearing radiation protection aprons or thyroid collars during radiography. Approximately 11.3% of the dental hygienists used radiation protection aprons or thyroid collars in their patients when obtaining all radiographs; specifically, 69% and 6.4% used radiation protection aprons or thyroid collars in their patients when obtaining dental CBCT images and panoramic radiographs, respectively (Table 4).

The effective dose of dental CBCT is lower than that of general computed tomography [21] but is higher than that of panoramic radiography [22]. Thus, the operator must attempt to reduce the radiation dose. In this study, the field of view (FOV) of CBCT was not investigated; however, it is necessary to adjust the FOV when obtaining CBCT images to prevent unnecessary irradiation.

It is important to follow the "as low as reasonably achievable" principle for children and adolescents who are sensitive to radiation. The effect of wearing radiation protective aprons when obtaining panoramic radiographs is controversial [23,24]; meanwhile, the use of thyroid shields when obtaining intraoral radiographs of the anterior teeth is effective in reducing the radiation exposure dose [25]. Considering that the American Dental Association also recommends the use of thyroid shields [26], it is necessary to change the attitudes of dental hygienists regarding wearing of thyroid shields in South Korea.

In this study, only 6.9% of the dental hygienists used a thyroid shield for personnel protection. According to a previous study [27], the more dental hygienists used radiation protection aprons for personnel protection, the better they practiced radiation protection for their patients. In another previous study, dental hygienists did not use radiation protective shields for personnel protection because it was not considered a common practice [28].

In this study, the most common reason for not wearing radiation protective shields was that their use was considered cumbersome and time-consuming.

Approximately 7.45% of the dental hygienists did not wear radiation protective aprons or thyroid collars owing to a lack of protective shields. Therefore, it is recommended to improve the dental environment by equipping personnel with protective aprons or shields as well by training dental workers in radiation protection.

In conclusion, significant differences were found in the learning pathway for the DRL, satisfaction with the radiation safety education program, and use of personnel radiation monitoring systems between the dental hygienists with < 10 years and ≥ 10 years of career experience ($p < 0.05$). Dental hygienists with more 10 years of experience were more satisfied with radiation safety education and more interested in radiation monitoring.

Despite the fact that dental clinics are equipped with radiation protective shields, there was a difference found in patient radiation protection depending on the type of radiography performed. Further, some dental hygienists were not aware of the definition of the DRL, which can be used to reduce the dose of exposure of patients to medical radiation, and 44.5% of the dental hygienists with < 10 years of experience were not satisfied with the radiation safety education program. It is recommended to provide customized radiation protection and safety management education to dental patients and dental radiation workers.

Acknowledgements

This work was supported by a grant (No. 2020-2001) from Chonnam National University.

Conflicts of Interest

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

References

1. Kang J, Gil J, Lee B, Lee H, Lee SS. A study on the current status and awareness improvement of radiation safety management systems in dentistry in Korea. Public Health Weekly Report 2020;13:1027-1036.
2. An SY, Lee KM, Lee JS. Korean dentists' perceptions and attitudes regarding radiation safety and protection. Dentomaxillofac Radiol 2018;47:20170228. doi: 10.1259/dmfr.20170228.
3. Lee BD, Ludlow JB. Attitude of the Korean dentists towards radiation safety and selection criteria. Imaging Sci Dent 2013;43:179-84. doi: 10.5624/isd.2013.43.3.179.
4. Kim YJ, Cha ES, Lee WJ. Occupational radiation procedures and doses in South Korean dentists. Community Dent Oral Epidemiol 2016;44:476-84. doi: 10.1111/cdoe.12237.
5. Kim EK. Radiation safety management in dental radiology: present status and future. J Korean Dent Assoc 2014;52:147-52.
6. Healthcare Big Data Hub [Internet]. Wonju: Health Insurance Review & Assessment Service; 2019 [cited 2021 Jan 3]. Available from: http://opendata.hira.or.kr/op/opc/olapDiagBhvInfo.do#none
7. Kang EJ, Hyeong JH. Current status of dental intraoral imaging devices and radiographic safety management. J Korean Soc Dent Hyg 2016;16:205-14. doi: 10.13065/jksdh.2016.16.02.205.
8. Medical institution facilities and equipment status [Internet]. Wonju: Health Insurance Review & Assessment Service; 2019 [cited 2021 Jan 3]. Available from: https://opendata.hira.or.kr/op/opc/selectMedInfoSvcList.do?datatp=Sheet#none
9. Jeong YH, Kwon YO, Lee JY, Heo SE, Yoon YS. Factors that affect the behavior on the radiation safety management for dental hygienists. J Dent Hyg Sci 2011;11:471-9.
10. Ryu JM, Kang BS, Kim SH. A study on radiation safety education, knowledge, and practice in using portable intraoral X-ray equipment of dental hygienist's. J Korean Soc Dent Hyg 2017;17:1053-65. doi: 10.13065/jksdh.2017.17.06.1053.
11. Fasola AO, Obiechina AE, Arotiba JT. Incidence and pattern of maxillofacial fractures in the elderly. Int J Oral Maxillofac Surg 2003;32:206-8. doi: 10.1054/ijom.2002.0323.
12. Korea Disease Control and Prevention Agency. Statistical yearbook of exposure dose of medical radiation workers [Internet]. Cheongju: Korea Disease Control and Prevention Agency; 2020 [cited 2021 Jan 3]. Available from: https://www.korea.kr/news/pressReleaseView.do?newsId=156426597&call_from=rsslink
13. Park J. Increasing trend of diagnostic equipment in medical institutions ... Raising concerns about radiation exposure [Internet]. Seoul: Health Korea News; 2020 [cited 2021 Jan 3]. Available from: https://www.hkn24.com/news/articleView.html?idxno=310724
14. ICRP. 1990 Recommendations of the International Commission on Radiological Protection. Ann ICRP 1991;21:1-201.
15. Vassileva J, Rehani M. Diagnostic reference levels. AJR Am J Roentgenol 2015;204:W1-3. doi: 10.2214/AJR.14.12794.
16. Korea Disease Control and Prevention Agency. 2019 Report occupational radiation exposure in diagnostic radiology in Korea [Internet]. Cheongju: Korea Disease Control and Prevention Agency; 2020 Dec [cited 2021 Jan 3]. Available from: https://www.kdca.go.kr/board/board.es?mid=a20305050000&bid=0003&act=view&list_no=711422&tag=&nPage=1
17. Oatway WB, Jones AL, Holmes S, Watson S, Cabianca T. Ionising radiation exposure of the UK population: 2010 review. London: Public Health England; 2016.
18. Frasch G, Kammerer L, Karofsky R, Mordek E, Schlosser A, Spiesl J. Occupational radiation exposure in Germany in 2013-2014. Report of the radiation protection register. Salzgitter: Bundesamt für Strahlenschutz; 2015 Oct. Report No.: BFS-SG--23/15.
19. Health Canada. Report on occupational radiation exposures in Canada [Internet]. Ottawa: Health Canada; 2018 [cited 2021 Feb 2]. Available from: https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/occupational-radiation-exposures.html
20. Council on Personal Dosimetry Services. Distribution table of effective dose by occupation in medical institutions. Tsukuba: Council on Personal Dosimetry Services; 2018 [cited 2021 Feb 2]. Available from: http://www.kosenkyo.jp/siryou/iryou30.PDF
21. Ngan DC, Kharbanda OP, Geenty JP, Darendeliler MA. Comparison of radiation levels from computed tomography and conventional dental radiographs. Aust Orthod J 2003;19:67-75.
22. Akyalcin S, English JD, Abramovitch KM, Rong XJ. Measurement of skin dose from cone-beam computed tomography imaging. Head Face Med 2013;9:28. doi: 10.1186/1746-160X-9-28.
23. Rottke D, Grossekettler L, Sawada K, Poxleitner P, Schulze D. Influence of lead apron shielding on absorbed doses from panoramic radiography. Dentomaxillofac Radiol 2013;42:

20130302. doi: 10.1259/dmfr.20130302.
24. Han GS, Cheng JG, Li G, Ma XC. Shielding effect of thyroid collar for digital panoramic radiography. Dentomaxillofac Radiol 2013;42:20130265. doi: 10.1259/dmfr.20130265.
25. Hoogeveen RC, Hazenoot B, Sanderink GC, Berkhout WE. The value of thyroid shielding in intraoral radiography. Dentomaxillofac Radiol 2016;45:20150407. doi: 10.1259/dmfr.20150407.
26. American Dental Association Council on Scientific Affairs, Food and Drug Administration. Dental radiographic examinations: recommendations for patient selection and limiting radiation exposure [Internet]. Chicago, Silver Spring: American Dental Association, Food and Drug Administration; 2012 [cited 2021 Apr 3]. Available from: https://www.fda.gov/media/84818/download
27. Seong MK, Jang KA. Influences on radiation safety management practice of general characteristics and radiation safety management practice for dental hygienists in Busan and Gyeongnam province. J Dent Hyg Sci 2013;13:264-70.
28. Yoon JA, Yoon YS. Comparing with self-efficacy and knowledge, attitudes about radiation safety management of dental hygienists and students at department of dental hygiene. J Korean Soc Dent Hyg 2011;11:729-39.

Appendix. Questionnaire for dental hygienists

This survey aims to investigate radiation safety management. Your response will be used as research data, and to protect your private information, the name of your dental clinic and your background will not be presented in the research paper. Thank you for your cooperation!

1. Mark your sex.
   1) Man 2) Woman

2. Write down the year that you acquired your hygienist license (_____)
   and working place (for example, metropolitan city or province) (_____).

3. Write down the types of installed radiographic machines in your working place.

4. Have you heard of the diagnostic reference level or reference dose, which is reported in the field of dentistry for optimizing the medical radiation exposure level?
   1) Yes 2) No

5. If you are familiar with the patient reference dose, how did you learn about it?
   1) At a radiation safety training 2) At other places (_____)

6. Who usually attends the radiation safety training at your dental clinic?
   1) Head dentist 2) Employees

7. Does the radiation safety training help you manage the radiographic equipment or explain radiation safety to patients?
   1) Yes (satisfied) 2) No

8. What method of imaging technique do you use for intraoral radiography?
   1) Bisecting technique
   2) Paralleling technique (obtaining the image using an image receptor device)

9. When does a patient put on a thyroid collar or a lead apron?
   1) During periapical radiographic imaging
   2) During panoramic radiographic imaging
   3) During cephalometric radiographic imaging
   4) During cone-beam computed tomography
   5) Only when the parent/guardian requests
   6) All imaging processes

10. You are working at a dental clinic with radiographic equipment. Have you monitored the amount of radiation you are exposed to (using a personal dosimeter or TLD badge)?
    1) Yes 2) No

11. When a dental assistant goes into the imaging room to hold a radiographic film or digital sensor, does the dental assistant wear a thyroid collar?
    1) Yes 2) No

*If you answered "No," what is the reason? (_____)