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Original Article

The dental radiology course design related to the application of the cone-beam computed tomography for the continuing education of the medical radiation technologists in Taiwan

Feng-Chou Cheng [a,b,c], Mu-Hsiung Chen [d], Chih-Kai Huang [e], Yu-Wen Wang [e], Chun-Chao Chuang [f,g**], Chun-Pin Chiang [d,h,i,j*]

[a] *Chia-Te Dental Clinic, New Taipei City, Taiwan*
[b] *School of Life Science, College of Science, National Taiwan Normal University, Taipei, Taiwan*
[c] *Science Education Center, National Taiwan Normal University, Taipei, Taiwan*
[d] *Department of Dentistry, National Taiwan University Hospital, College of Medicine, National Taiwan University, Taipei, Taiwan*
[e] *Department of Medical Imaging, National Taiwan University Hospital, College of Medicine, National Taiwan University, Taipei, Taiwan*
[f] *Department of Medical Imaging and Radiological Sciences, Chung Shan Medical University, Taichung, Taiwan*
[g] *Department of Medical Imaging, Chung Shan Medical University Hospital, Taichung, Taiwan*
[h] *Graduate Institute of Oral Biology, School of Dentistry, National Taiwan University, Taipei, Taiwan*
[i] *Department of Dentistry, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan*
[j] *Institute of Oral Medicine and Materials, College of Medicine, Tzu Chi University, Hualien, Taiwan*

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KEYWORDS
Dental radiology;
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Abstract *Background/purpose:* In Taiwan, a new frontier related to the dental radiology for the medical radiation technologists is under development. This study assessed the participants' learning outcomes after finishing the dental radiology course related to the application of cone-beam computed tomography (CBCT) for the continuing education of the medical radiation technologists in Taiwan.

* Corresponding author. Department of Dentistry, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, and Institute of Oral Medicine and Materials, College of Medicine, Tzu Chi University, No. 707, Section 3, Chung-Yang Road, Hualien 970, Taiwan.
** Corresponding author. Department of Medical Imaging and Radiological Sciences, College of Medical Science and Technology, Chung Shan Medical University, No. 110, Section 1, Jianguo North Road, Taichung City, 402, Taiwan.
E-mail addresses: jimchao@csmu.edu.tw (C.-C. Chuang), cpchiang@ntu.edu.tw (C.-P. Chiang).

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Medical radiation technologist;
Continuing education

Materials and methods: This study used the questionnaire survey to evaluate the participants' learning outcomes after finishing the dental radiology course for the continuing education of the medical radiation technologists in Taiwan.
Results: In this study, 41 participants filled out the questionnaires completely after finishing the dental radiology course. The results showed that most of participants found this course to be helpful in raising their basic knowledge about the dental radiology, their attitude towards the dental radiology, and their interest in further learning of the dental radiology. They were satisfied with the courses. The degree of agreement for each question was high with all the mean scores for each question being between 4.34 and 4.68. The numbers (rates) of respondents who answered as strongly agree were between 19 (46.34 %) and 29 (70.73 %).
Conclusion: The dental radiology course for the continuing education of the medical radiation technologists has proven to increase the participants' basic knowledge about the dental radiology, and their awareness of the dental radiation protection. Thus, this model can be continuously used for contributing to the ongoing development of this new frontier related to the dental radiology continuing education course for the medical radiation technologists in Taiwan.

Introduction

The increasingly popular cone-beam computed tomography (CBCT) has become the most effective diagnostic and evaluation tool in the field of oral and dental care today. Especially, when it comes to the assessment of jawbone and tooth structures in the oral surgery and endodontics, the CBCT is an indispensable tool.[1] Compared with the computed tomography (CT), the CBCT has more prominent image advantages in the dental applications. It provides a higher dental image resolution, but uses only a small amount of radiation exposure dose. Moreover, the cone-beam design also makes it more accurate in the dental image scanning. The clinical application of the CBCT in tooth-related diseases has become popular in the field of the dentistry today, especially in the clinical application for the diagnosis of endodontic-related tooth or jaw bone diseases. The CBCT provides a three-dimensional (3D) stereoscopic image perspective, allowing the clinicians to more accurately observe and evaluate the condition of the tooth roots and surrounding alveolar bone structures.[2–4] By using the CBCT technology, the clinicians can clearly assess whether there are infections, cysts, or other abnormalities around the tooth roots.

Based on the importance of the CBCT in the field of the medical imaging and its widespread use, there is an increasing demand for the medical radiation technologists to operate the CBCT to assist the dentists in their dental procedures.[5] Therefore, for the medical radiation technologists, the application of the CBCT in dentistry, its advantages, disadvantages, and limitations, as well as the radiation dose issues are worthy of attention. Professionally, the medical radiation technologists are capable of assisting the dentists in assessing each patient's condition and implementing the relevant radiation protection in the use of the CBCT. In addition, it is needed to ensure the correct operation and maintenance of the CBCT equipment to reduce the possible risks.

Due to a new trial, the Taichung City Association of Radiological Technologists (TCART) designed a 3-h dental radiology course related to the application of the CBCT in the endodontics and its radiation protection for the continuing education of the medical radiation technologists in November 2023. In addition to the medical radiation technologists, the relevant practitioners were also welcome to participate in this continuing education course. This 3-h dental radiology course was an introduction to the application of the CBCT in the endodontics, and aimed to enhance the participants' understanding of the growing relationship between the dental procedures and the CBCT. The purpose of this study was to assess the participants' learning outcomes after finishing the dental radiology course for the continuing education of the medical radiation technologists in Taiwan. Thus, a questionnaire survey was conducted to understand whether this dental radiology course could increase the participants' basic knowledge about the application of the CBCT and their awareness and understanding of the radiation protection in the dental radiography. The results of this study will be further used as a reference for the establishment of the dental radiology course for the continuing education of the medical radiation technologists in Taiwan.

Materials and methods

Participants

All subjects participating in the dental radiology course related to the application of the CBCT in the endodontics and its radiation protection for the continuing education of the medical radiation technologists offered by the TCART in November 2023 were included in this study. Their gender, main working field, and professional occupation were confirmed by the questionnaire survey and were used as the basis for grouping the participants.

Teaching process

This continuing education course was a specific 3-h dental radiology course for the in-service medical radiation technologists and the relevant practitioners. It was performed

in the form of lectures and was offered to the TCART members who were mainly the medical radiation technologists. The course content included the principles and techniques of the CBCT, its application in the endodontics, and the radiation protection in the dental radiography. It was taught by a senior dentist specializing in the application of the CBCT in the endodontic procedures. An online questionnaire link was given to the participants who completed this dental radiology continuing education course after the class.

Survey tool

This study used the method of the dental radiology education survey by questionnaire to evaluate the participants' learning outcomes by assessing their perceptions of the dental radiology course. All participants who completed this dental radiology continuing education course were invited to fill out the questionnaire for the dental radiology education survey after the class. The purpose of this survey was to analyze the participants' cognition for the concepts of the dental radiology after the course. All participants were invited to join in this survey at their free will to fill out the questionnaire without the pressure from the investigators.

A structured questionnaire-based online survey was used as the survey tool to understand the participants' cognition and attitude for the dental radiology. The questions about the participants' basic information included their gender, main working field, and professional occupation, as well as the main reasons for participating in this course and their learning experience about the dental radiology before this course. The questionnaire was designed for obligating the participants to answer all the questions and to make sure that the returned electronic survey forms were all complete. The investigated questions included (1) the self-assessment of the participants' cognition for the knowledge about the CBCT (questions 1, 2, 3 and 4), (2) the attitude towards the dental radiation protection and the interest in further learning of the CBCT (questions 5, 6 and 7), and (3) the personal viewpoint for this dental radiology continuing education course (questions 8 and 9).

In the investigated questions, the answer was designed to let the participant to raise a score ranging from 1 to 5. If the intensity or response for each question was strongly agreed, the score was 5. If the intensity or response for each question was neutral, the score was 3. In contrast, if the intensity or response for each question was strongly disagreed, the score was 1. The mean score of 3 or more meant that on average the answerers agreed the investigated questions, and the higher the score, the higher the degree of their agreement. The participants were suggested to fill the score or answer in the fresh memory.

Statistical analysis

All data obtained from the participants were stored in excel files and used for the statistical analysis. The differences in the mean scores (the degree of agreement) of the various investigated items were compared between two different groups of the participants by the independent sample *t-test*. The result was considered to be significant if the *P*-value was less than 0.05.

Results

Demographic data

A total of 169 participants who completed this dental radiology course for the continuing education of the medical radiation technologists offered by the TCART in November 2023 were included in this study. Among them, 41 participants filled out the questionnaires completely after the class. The valid response rate was 24.26 %. Of these 41 respondents, there were 24 (58.54 %) males and 17 (41.46 %) females. For the main working field, most of them were engaged in the diagnostic radiology (26, 63.41 %), followed by the radiation therapy (7, 17.07 %), the nuclear medicine (6, 14.63 %), and others (2, 4.88 %). Among them, the diagnostic radiology included the general diagnostic radiology (21, 51.22 %) and the dental radiology (5, 12.20 %), while others included the surgery (1, 2.44 %) and cardiac catheterization (1, 2.44 %). In addition, for the professional occupation, most of them were the medical radiation technologists (27, 65.85 %), followed by the medical radiation technologists with radiation protection personnel certificates (9, 21.95 %), the radiation protection personnel (3, 7.32 %), and the dentists (2, 4.88 %) (Table 1).

Table 1 Distribution of the respondents (n = 41) who filled out the questionnaires after finishing the dental radiology course related to the application of the cone-beam computed tomography (CBCT) in the endodontics and its radiation protection for the continuing education of the medical radiation technologists offered by the Taichung City Association of Radiological Technologists (TCART) in November 2023.

Category	Number (proportion) of respondents (n = 41)			
Gender	Male	Female		
	24 (58.54 %)	17 (41.46 %)		
Main working field[a]	Diagnostic radiology	Radiation therapy	Nuclear medicine	Others
	26 (63.41 %)	7 (17.07 %)	6 (14.63 %)	2 (4.88 %)
Professional occupation	Medical radiation technologist	Medical radiation technologist with radiation protection personnel certificate	Radiation protection personnel	Dentist
	27 (65.85 %)	9 (21.95 %)	3 (7.32 %)	2 (4.88 %)

[a] In the main working field, the diagnostic radiology included the general diagnostic radiology (n = 21) and the dental radiology (n = 5), while others included the surgery (n = 1) and cardiac catheterization (n = 1).

Main reasons for participating in this dental radiology course for the continuing education of the medical radiation technologists

In terms of the main reasons for the participants to choose this dental radiology continuing education course in this questionnaire, there were three reasons for the selection, and these included (1) the interesting course topics, (2) the convenient location for the classes, and (3) the accumulation of the continuing education points. Multiple selections were allowed. The sum of the frequencies of the various reasons being chosen was 80 in total. Overall, among the three reasons, the highest frequency (proportion) was to accumulate the continuing education points (35, 43.75 %), followed by the interesting course topics (29, 36.25 %) and the convenient location for the classes (16, 20 %). Only among the participants whose main working field was others or whose professional occupation was the dentists, the highest frequency (proportion) was the interesting course topics (2, 66.67 % and 2, 50 %, respectively). Among the participants based on the various other groupings, the highest frequency (proportion) was always to accumulate the continuing education points. Especially among those whose main working field was the radiation therapy, the frequency (proportion) of accumulating the continuing education points was as high as 7 (63.64 %) (Table 2).

Learning experience about the dental radiology before this dental radiology course for the continuing education of the medical radiation technologists

In terms of the learning experience for the participants about the dental radiology in this questionnaire, there were two questions for the selection, and these included (1) I had the learning experience about the dental radiology in my school courses and (2) I had the learning experience about the dental radiology in my continuing education courses. Based on the participants' responses, only 5 (12.20 %) of the 41 participants had the learning experience about the dental radiology in the school courses, and only 9 (21.95 %) of the 41 participants had the learning experience about the dental radiology in the continuing education courses. Among the dentists, 100 % (2/2) and 50 % (1/2) had the learning experience about the dental radiology in their school courses and in their continuing education courses, respectively. Moreover, among other professional personnel, they generally had no learning experience about the dental radiology in their school courses and in their continuing education courses (Table 3).

Cognition for the concepts of dental radiology after this dental radiology course for the continuing education of the medical radiation technologists

In this questionnaire, there were 9 investigated questions related to the participants' cognition for (1) the basic knowledge about the CBCT, (2) the attitude towards the dental radiation protection and the interest in the further learning of the CBCT, and (3) the personal viewpoint for this dental radiology continuing education course (Table 4).

According to the respondents' assessment, most of them agreed that this dental radiology continuing education course to be helpful in raising their basic knowledge about the CBCT (such as the principles of the CBCT and its application in the various dental treatments and the endodontics) and the radiation protection. Moreover, most of the participants agreed the concept of the radiation protection principle of as low as reasonably achievable (ALARA), had the interest in further learning about the advanced dental radiology techniques (such as the operating techniques of the CBCT), and considered the dental radiology to be a suitable option for the medical radiation technologist career development. They also agreed that

Table 2 Main reasons of the respondents for participating in the dental radiology course for the continuing education of the medical radiation technologists.

Category	Frequency (proportion) of reasons (n = 80)		
	Interesting course topics	Convenient location for the classes	Accumulation of the continuing education points
Gender			
Male	18 (40 %)	9 (20 %)	18 (40 %)
Female	11 (31.43 %)	7 (20 %)	17 (48.57 %)
Main working field			
Diagnostic radiology	22 (40 %)	11 (20 %)	22 (40 %)
Radiation therapy	2 (18.18 %)	2 (18.18 %)	7 (63.64 %)
Nuclear medicine	3 (27.27 %)	3 (27.27 %)	5 (45.45 %)
Others	2 (66.67 %)	0	1 (33.33 %)
Professional occupation			
Medical radiation technologist	20 (38.46 %)	9 (17.31 %)	23 (44.23 %)
Medical radiation technologist with radiation protection personnel certificate	5 (31.25 %)	3 (18.75 %)	8 (50 %)
Radiation protection personnel	2 (25 %)	3 (37.5 %)	3 (37.5 %)
Dentist	2 (50 %)	1 (25 %)	1 (25 %)
Overall	29 (23.49 %)	16 (29.53 %)	35 (46.98 %)

Table 3 The respondents' learning experience about the dental radiology before the dental radiology course for the continuing education of the medical radiation technologists.

Learning experience	Number (proportion) of respondents (n = 41)	
	Yes	No
A. I Had the learning experience about the dental radiology in my school curricula.		
Medical radiation technologist (n = 27)	0	27 (100 %)
Medical radiation technologist with radiation protection personnel certificate (n = 9)	2 (22.22 %)	7 (77.78 %)
Radiation protection personnel (n = 3)	1 (33.33 %)	2 (66.67 %)
Dentist (n = 2)	2 (100 %)	0
Overall (n = 41)	5 (12.20 %)	36 (87.80 %)
B. I Had the learning experience about the dental radiology in my continuing education courses.		
Medical radiation technologist (n = 27)	4 (14.81 %)	23 (85.19 %)
Medical radiation technologist with radiation protection personnel certificate (n = 9)	3 (33.33 %)	6 (66.67 %)
Radiation protection personnel (n = 3)	1 (33.33 %)	2 (66.67 %)
Dentist (n = 2)	1 (50 %)	1 (50 %)
Overall (n = 41)	9 (21.95 %)	32 (78.05 %)

Table 4 Question content and question type used in the questionnaire survey by the self-assessment of respondents' cognition for the concepts of the dental radiology after finishing the dental radiology course for the continuing education of the medical radiation technologists and the survey results.

Question content	Question type	Mean score ± SD	Number (rate) of respondents who answered as strongly agree
1. After participating in this course, I consider that the course content helps me understand the principles of dental cone-beam computed tomography (CBCT)	For knowledge, multiple choice	4.68 ± 0.52	29 (70.73 %)
2. After participating in this course, I consider that the course content helps me understand the application of the CBCT in various dental treatments.	For knowledge, multiple choice	4.59 ± 0.55	25 (60.98 %)
3. After participating in this course, I consider that the course content helps me understand the application of the CBCT in the endodontics.	For knowledge, multiple choice	4.61 ± 0.54	26 (63.41 %)
4. After participating in this course, I consider that the course content helps me understand the radiation protection of the CBCT	For knowledge, multiple choice	4.59 ± 0.55	25 (60.98 %)
5. For the concept of radiation protection, the dental radiation work is the same as other radiation work. The dental radiation workers also need to have good radiology techniques (including dental radiology techniques) to reduce unnecessary re-irradiation, which can reduce the radiation exposure dose of the patients and the environment, to comply with the principle of as low as reasonably achievable (ALARA).	For attitude, multiple choice	4.63 ± 0.54	27 (65.85 %)
6. I Am interested in learning about the advanced dental radiology techniques, such as the operating techniques of the CBCT and its radiation parameter settings for the various dental diseases.	For attitude, multiple choice	4.51 ± 0.55	22 (53.66 %)
7. After participating in this course, I consider that the dental radiology is also one of the options suitable for the career development as a medical radiation technologist.	For attitude, multiple choice	4.56 ± 0.55	24 (58.54 %)
8. Overall, this course is helpful for my works.	For viewpoint, multiple choice	4.34 ± 0.73	19 (46.34 %)
9. Overall, I am satisfied with this course.	For viewpoint, multiple choice	4.63 ± 0.54	27 (65.85 %)

SD: Standard deviation.

Table 5 Comparison of the respondents' cognition for the concepts of the dental radiology between the male and female respondents after finishing the dental radiology course for the continuing education of the medical radiation technologists.

Questions	Male (n = 24)		Female (n = 17)		*t-test*
	Mean score ± SD	Number (rate) of the respondents who answered as strongly agree	Mean score ± SD	Number (rate) of the respondents who answered as strongly agree	*P*-value
Question 1	4.79 ± 0.41	19 (79.17 %)	4.53 ± 0.62	10 (58.82 %)	0.057
Question 2	4.63 ± 0.49	15 (62.5 %)	4.53 ± 0.62	10 (58.82 %)	0.294
Question 3	4.67 ± 048	16 (66.67 %)	4.53 ± 0.62	10 (58.82 %)	0.216
Question 4	4.67 ± 0.48	16 (66.67 %)	4.47 ± 0.62	9 (52.94 %)	0.132
Question 5	4.75 ± 0.44	18 (75 %)	4.47 ± 0.62	9 (52.94 %)	0.050
Question 6	4.71 ± 0.46	17 (70.83 %)	4.24 ± 0.56	5 (29.41 %)	0.003**
Question 7	4.71 ± 0.46	77 (70.83 %)	4.35 ± 0.61	7 (41.18 %)	0.020*
Question 8	4.63 ± 0.49	15 (62.5 %)	3.94 ± 0.83	4 (23.53 %)	0.001**
Question 9	4.71 ± 0.46	17 (70.83 %)	4.53 ± 0.62	10 (58.82 %)	0.149

SD: Standard deviation.
*$P < 0.05$; **$P < 0.01$.

the course was helpful for the works and they were satisfied with this course. The degree of agreement for each question was high with the mean scores for each question being between 4.34 and 4.68. The numbers (rates) of the respondents who answered as strongly agree were between 19 (46.34 %) and 29 (70.73 %). Due to these mean scores were all more than 3, it meant that on average the answerers agreed all the investigated questions (Table 4).

Comparisons of respondents' cognition for the concepts of dental radiology after this dental radiology course for the continuing education of the medical radiation technologists

The differences in the mean scores of the investigated questions were compared between the male and female respondents and between those whose main working field was in the diagnostic radiology and those whose main working field was outside the diagnostic radiology (Tables 5 and 6).

For the comparison between the male and female respondents, all the mean scores for each question answered by the male respondents were higher than those answered by the female respondents. The differences in the mean score of questions 6, 7 and 8 were significant ($P < 0.05$ for question 7, and $P < 0.01$ for questions 6 and 8) (Table 5). In the self-assessment of the male respondents after this dental radiology course, the degree of raising their basic knowledge about the CBCT, their attitude towards the dental radiation protection, and their interest in the further learning about the techniques of the CBCT was higher than that of the female respondents. Moreover, the male respondents were more affirmed this dental radiology course to be helpful for their future works and satisfied with this course (Table 5).

Table 6 The comparison of the respondents' cognition for the concepts of the dental radiology between those whose main working field was in the diagnostic radiology and those whose main working field was outside the diagnostic radiology after finishing the dental radiology course for the continuing education of the medical radiation technologists.

Questions	Those whose main working field was in the diagnostic radiology (n = 26)		Those whose main working field was outside the diagnostic radiology (n = 15)		*t-test*
	Mean score ± SD	Number (rate) of the respondents who answered as strongly agree	Mean score ± SD	Number (rate) of the respondents who answered as strongly agree	*P*-value
Question 1	4.77 ± 0.43	20 (76.92 %)	4.53 ± 0.64	9 (60 %)	0.083
Question 2	4.69 ± 0.47	18 (69.23 %)	4.40 ± 0.63	7 (46.67 %)	0.050
Question 3	4.73 ± 0.45	19 (73.08 %)	4.40 ± 0.63	7 (46.67 %)	0.029*
Question 4	4.69 ± 0.47	18 (69.23 %)	4.40 ± 0.63	7 (46.67 %)	0.050
Question 5	4.73 ± 0.45	19 (73.08 %)	4.47 ± 0.64	8 (53.33 %)	0.065
Question 6	4.62 ± 0.50	16 (61.54 %)	4.33 ± 0.62	6 (40 %)	0.059
Question 7	4.62 ± 0.50	16 (61.54 %)	4.47 ± 0.64	8 (53.33 %)	0.206
Question 8	4.50 ± 0.58	14 (53.85 %)	4.07 ± 0.88	5 (33.33 %)	0.033*
Question 9	4.81 ± 0.40	21 (80.77 %)	4.33 ± 0.62	6 (40 %)	0.002**

SD: Standard deviation.
*$P < 0.05$; **$P < 0.01$.

For the comparison between those whose main working field was in the diagnostic radiology (including the dental radiology) and those whose main working field was outside the diagnostic radiology, all the mean scores for the questions of the respondents in the diagnostic radiology were higher than those answered by the respondents outside the diagnostic radiology. The differences in the mean score of questions 3, 8 and 9 were significant ($P < 0.05$ for questions 3 and 8, and $P < 0.01$ for question 9) (Table 5). In the self-assessment of the respondents in the diagnostic radiology after finishing the dental radiology course, the degree of raising their basic knowledge about the CBCT (especially its application in the endodontics), their attitude towards the dental radiation protection, and their interest in the further learning about the techniques of the CBCT was higher than that of the respondents outside the diagnostic radiology. In addition, the respondents in the diagnostic radiology were also more affirmed this course to be helpful for their future works and satisfied with this dental radiology continuing education course (Table 6).

Discussion

When the first X-ray machine for the diagnosis of dental and jawbone diseases was manufactured by the current German company Siemens in 1905, soon there was an article that introduced the value of X-ray for the diagnosis of dental diseases with photobook published in the Journal of the Formosan Medical Association by the Taiwan Government Taipei Hospital, the predecessor of National Taiwan University Hospital (NTUH) in 1913.[6–10] This means that the development of dental radiology in Taiwan is almost synchronized with the world. Additionally, there was another article that introduced the dental radiography technology (such as the placement of bisecting-angle technique) published in the Journal of the Taiwan Radiology Association by the Radiology Department of Taiwan Government Tainan Hospital in 1932.[9,10] This confirms that dental radiation work has already been included in the business of the medical imaging department at that time, and also shows that dental radiology has long been one of the professional items of the medical radiation technologists in Taiwan. Thus, the dental radiology has been developing in Taiwan for a long time for both the dentistry and the medical radiology.

In Taiwan, the formal education for cultivating the medical radiation technologists established at the Yuanpei Junior College (restructured into a university in 2005) in 1965 had its first batch of graduates in 1970. The NTUH established a dedicated dental radiology room in 1979. Moreover, in addition to the dentists, the medical radiation technologists are the only personnel who can legally operate the dental X-ray machines.[11,12] According to the definition of Taiwan Nuclear Safety Commission (NSC), the medical radiation work includes four categories of diagnostic radiology, dental radiology, nuclear medicine, and radiation therapy. According to our previous study, among the medical radiation workers engaged in the radiation practice (such as the operation of radiation equipment or the business of related radiation protection), the largest number of them were 15,384 working in the diagnostic radiology, followed by the radiation therapy (1,752), the nuclear medicine (1,117), and finally the dental radiology (770) in Taiwan in 2020.[13] The medical radiation technologists, on the other hand, are included under the definition of the medical radiation workers. According to our previous survey, however, among the hospitals, there were only 101 medical radiation technologists working full-time in the dental radiology in Taiwan in 2021.[14] In the same year, there were as many as 7085 practicing medical radiation technologists. Among them, however, 6518 worked in the hospitals, and only 29 worked in the dental clinics and 2 in the dental hospital. It should be noted that there is currently only one dental hospital in Taiwan. Although the dental radiology is one of the four major categories of medical radiation work, the medical radiation technologists engaged in the dental radiology in Taiwan are very few in number and proportion.[13,14] Therefore, there should be considerable space for the growth in the working field of dental radiology for the medical radiation technologists in the future.

The dental radiology as a common field of the dentistry and the medical radiology is an important portion for the dental practice. However, the dental radiology is just a small item in the general radiography for the diagnostic radiology, resulting in the rare offer of the independent dental radiology courses in the medical radiology schools.[5,15] Therefore, in this study, the dental radiology course related to the application of the CBCT in the endodontics and its radiation protection was designed for the continuing education of the medical radiation technologists to create their opportunity for learning about the knowledge of the advanced dental radiology. Further, we explored the participants' cognition for this dental radiology course after the class through the questionnaire survey. The participants' feedback on this course was also investigated. Regarding their working field, they were mainly engaged in the diagnostic radiology (including general diagnostic radiology and dental radiology), followed by the radiation therapy and the nuclear medicine. In proportion, this was consistent with the fact that the vast majority of the medical radiation workers worked in the diagnostic radiology.[13,14] Moreover, the participants were mainly the medical radiation technologists, followed by the radiation protection personnel and the dentist. Among them, the motivations of participating in this course were mainly for the accumulation of the continuing education points, followed by the interesting course topics, indicating that the dental radiology course content is an interesting topic, and the dental radiology course design is worthy of implementation under the continuing education system. In addition, most of them satisfied with this course, and the dental radiology continuing education course was found to be helpful in raising their basic knowledge about the CBCT and its radiation protection, their attitude towards the dental radiology, and their interest in further learning about the advanced dental radiology techniques, such as the operating techniques of the CBCT.

In this study, the male participants had more positive feedback on the dental radiology course than the female participants, showing that the male participants are more confident in their self-assessment of the learning effectiveness of this course, especially the interest in learning

about the advanced dental radiology techniques related to the CBCT, the recognition of the dental radiology being also one of the options suitable for the career development as a medical radiation technologist, and the agreement of this course to be helpful for their future works. Moreover, those whose main working field was in the diagnostic radiology had more positive feedback on this dental radiology course than those whose main working field was outside the diagnostic radiology. This indicates that the participants in the diagnostic radiology are more confident in their self-assessment of the learning effectiveness of this course, especially the acquisition of the relevant knowledge of the application of the CBCT in the endodontics, and the agreement of this course to be helpful for their future works. It can be seen that the medical radiation technologists engaged in the diagnostic radiology will find it easier to learn the dental radiology.

The importance and usage of the dental radiology in the dental procedures are increasing day by day. Currently, both the dental departments of hospitals and the dental clinics have various types of dental X-ray machine, such as the periapical, bite-wing, occlusal, panoramic, and cephalometric radiographies. In addition, the hospitals also routinely install dental X-ray machines for special dental radiographies, such as the CBCT, the hand plate, the temporomandibular joint (TMJ) and the skull/maxillofacial radiographies.[16] In Taiwan, the CBCT has become more and more common and has become a basic equipment in the general dental clinics in recent years.[17] Although the dentists rely heavily on the dental radiography (such as for the evaluation of pre- and post-treatment and for the detection and diagnosis of dental diseases), they rarely receive assistance from the medical radiation technologists in operating the equipment.[13,14] The medical radiation technologists with a professional training background in the medical imaging are the most capable and suitable for operating various dental X-ray equipment (especially the CBCT). Their participation in the dental team may help to improve the quality of the dental care. Moreover, there were 16,285 dentists among 7237 dental institutions (including 211 dental departments of hospitals and 7026 dental clinics) in Taiwan in 2023.[18] It is inevitable that the dentists need professionals to assist with the large volume of the dental imaging tasks and the radiation protection. Therefore, it is an expected trend that the dentists need the medical radiation technologists to assist professionally in their dental radiography work.

In view of the increasing importance of dental radiology in the dentistry and the medical radiology, the dental radiology course for the continuing education of the medical radiation technologists has proven to increase the participants' basic knowledge about the dental radiology, and their awareness of the dental radiation protection. Thus, this model can be continuously used for contributing to the ongoing development of this new frontier related to the dental radiology for the medical radiation technologists in Taiwan. Furthermore, our medical radiology education system should consider expanding the field of the dental radiology in its undergraduate courses to enhance the accessibility of the future medical radiation technologists into the dental radiology.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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