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EVALUATION OF A CONTINUING EDUCATION DENTAL RADIOLOGY COURSE FOR MEDICAL RADIATION TECHNOLOGISTS IN TAIWAN: ENHANCING KNOWLEDGE AND RADIATION PROTECTION AWARENESS

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ABSTRACT
The education curriculum for medical radiation in Taiwan fails to include dental radiology as a subject. A study investigated the educational achievements of individuals who finished a dental radiology course that was developed for continuing education of medical radiation technologists. The questionnaire served as the research instrument to evaluate these outcomes after participants finished the course. The study received responses from all 85 participants who took part in the survey. Most participants confirmed that dental radiology instruction remains scarce throughout academic institutions and professional upgrading programs designed for medical radiation technologists. A majority of participants maintained that the course helped them learn dental radiology basics better while making dental radiology more appealing to them and driving them to take more trainings in this field. The participants consistently demonstrated positive views about the course. The participant response agreement on individual survey questions reached notably high levels based on the recorded average scores varying from 3.87 to 4.61 points. The survey data showed that 58 participants (68.24% of respondents) through to 84 participants (98.82%) marked agreement. All participants demonstrated improved core knowledge and increased levels of radiation safety understanding for dental imaging following completion of the dental radiology course. The educational model demonstrates strong potential for wider use in continuing education programs for medical radiation technologists operating throughout Taiwan

Keywords: Dental radiology, Dental radiography, Radiation protection, medical radiation technologist continuing education, medical radiation technologist

INTRODUCTION
Wilhelm Conrad Roentgen discovered X-rays during the late period of 1895. The world saw its first dental X-ray image appear in early 1896 after publication by Roentgen which happened just two weeks earlier. This breakthrough became possible through joint efforts between dentist Otto Walkhoff and Fritz Giesel. History was made by creating the first dental radiograph while simultaneously developing the role of radiographic procedure assistant. Medical and dental imaging have extensively adopted X-ray technology throughout the world since its initial discovery. Since 1905 when German

company Siemens built the first dental X-ray machine for oral and jawbone diagnosis the dental radiological field has exceeded 120 years while dental radiographic technicians have professionally evolved. Records from Taiwan demonstrate that dental X-ray technology started being used in an early stage. The 1913 Journal of the Formosan Medical Association article published by Taiwan Government Taipei Hospital included a photobook demonstration of dental radiographs for diagnosis which showed X-ray machines were in use in Taiwan since the 1910s. Kao and Shu commented on dental radiographic techniques in a 1932 publication of the Journal of Taiwan Radiology Association which originated from the Radiology Department at Taiwan Government Tainan Hospital. The evidence indicates dental X-ray machines were used regularly by Taiwanese dentists during the 1930s.[45] As such dental radiography in Taiwan spans more than one hundred years. Medical radiation technologist training started officially at Yuanpei Junior College in 1965 which later developed into a university in 2005. Medical radiation technologists started taking their national licensure exam in 1978 while the Medical Radiation Technologists Act came into effect in 2000 (1-3). The present enrollment statistics show that Taiwan runs ten separate educational programs focused on medical radiation technology education. The established dental radiology practice lasts many years but dental radiology education lacks a unified system or basic structure. Several education centers lack an independent dental radiology course which results in medical radiation students receiving little or no instruction about dental diagnostic methods. As dental radiology merges dental practice and radiology science it requires radiation technologists to develop ongoing expertise in this field throughout their careers. All medical radiation personnel need radiation protection education and training according to the Taiwan Ionizing Radiation Protection Act (IRPA). Healthcare authorities recognize medical radiation technologists together with dentists as the authorized personnel to operate dental X-ray machines. The technologists gain official approval as radiation workers through their recognition in the IRPA guidelines. Taichung City Association of Radiological Technologists (TCART) launched a 2023 dental radiology course comprised of 3 hours for ongoing education of medical radiation technologists. Besides radiation workers the course provided training to any professional with a role in related areas of practice. The introduction to dental radiology was delivered within a three-hour period to improve understanding about the increasing use of imaging techniques in dental clinical practice(4,5). The program delivered necessary information about basic dental radiographic techniques together with essential dental radiology concepts. The main reason for this study was to assess the learning achievements of course participants after finishing the training. The research executed a questionnaire survey to determine if the course taught students essential dental radiology principles and improved their dental imaging safety perception abilities. This research serves to guide future development in creating standard dental radiology educational programs for Taiwanese medical radiation technologists in continuing education.

MATERIALS AND METHODS

Participants

Every participant from the dental radiology course named “Dental Radiography and Radiation Protection” at TCART July 2023 gained admission under this research as part of their continuing education for medical radiation technologists. The survey obtained participant information that served to divide the subjects into different groups based on their gender and their professional experience length and employment type and field of work.

TEACHING PROCESS

The educational program provided concentrated dental radiology instruction to medical radiation technologists together with associated experts. Lecture-based delivery served the educational material to members of the Taichung City Association of Radiological Technologists (TCART) who largely consisted of certified medical radiation technologists. The program presented students with basic understanding of dental radiographic techniques and provided needed directions for radiation protection in dental X-ray facilities. A medical radiation technologist who held the title of senior led

the session at National Taiwan University Hospital Department of Dentistry. Learning evaluation through an online survey link became available for participants immediately after the completion of the course.

Survey tool

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The content of the survey questions covered four main areas:

(1) prior exposure to dental radiology courses within medical radiation school curricula and continuing education programmes (questions 1 and 2);
(2) self-assessed knowledge and understanding of dental radiology (questions 3 and 4);
(3) attitudes towards radiation protection in dental imaging and interest in further learning (questions 5, 6, and 7); and
(4) personal evaluation of the course content and delivery (questions 8 and 9).

Responses were rated using a five-point Likert scale, where a score of 5 indicated strong agreement, 3 indicated a neutral stance, and 1 indicated strong disagreement. An average score of 3 or higher suggested general agreement with the statement, with higher scores reflecting stronger agreement. Participants were encouraged to complete the survey while their impressions and course experiences were still fresh.

Statistical analysis

The gathered data from participants got assembled in Excel spreadsheets before researchers conducted statistical analysis. An independent samples t-test evaluated the mean scores which represented agreement levels between two separate participant groups in regard to their responses throughout different survey elements. Statistical significance existed when p-value reached below 0.05.

RESULTS

The results in Tables 1 and 2 give important insights into what medical radiation technologists learn and think about dental radiology after their training. Table 1 examines the amount of dental radiology the respondents had learned or seen before enrolling in the continuing education course. It is clear from the survey that only about one in four (23.53%) students learned about dental radiology in school. Among medical radiation technologists, the rate for being exposed was almost the same with and without a radiation protection certificate, both at about 25%, while those in the “Others” group reported an exposure rate of 9.09%. Furthermore, fewer respondents said they gained experience in dental radiology through continuing education courses, with 18.82% of these respondents which suggests dental radiology is not covered thoroughly either in official schooling or by prior courses. In Table 2, we assess if participants had learned basic dental radiology information after the course, based on their gender. All nine questions received scores mostly between 4.0 and 4.7, meaning that men and women shared broad agreement and clear understanding. In particular, the course taught the main concepts well, as male participants agreed with items 3, 4, 5 and 9 by 100% and females were close to agreeing as well. Minor variations in test scores were present between males and females, suggesting they understand the same lesson upon completion of training. The research shows that first

exposure to dental radiology may be insufficient for medical radiation technologists, but dedicated education on certain topics can increase their knowledge and confidence, aiding their work and clinical skills.

Table 1. Respondents' learning experience about dental radiology before the dental radiology course for the continuing education of medical radiation technologists.

Learning Experience	Number (proportion) of respondents (n = 85)
	Yes
A. I had learning experience about dental radiology in my school curricula.	
Medical radiation technologist (n = 58)	15 (25.86%)
Medical radiation technologist with radiation protection personnel certificate (n = 16)	4 (25.00%)
Others (n = 11)	1 (9.09%)
Overall	20 (23.53%)
B. I had learning experience about dental radiology in continuing education courses.	
Medical radiation technologist (n = 58)	12 (20.69%)
Medical radiation technologist with radiation protection personnel certificate (n = 16)	3 (18.75%)
Others (n = 11)	1 (9.09%)
Overall	16 (18.82%)

Table 2. Comparison of respondents' cognition for the concepts of dental radiology between male and female respondents after finishing the dental radiology course for the continuing education of medical radiation technologists.

Questions	Male (n = 30)	Female (n = 55)	t-test
	Mean score ± SD	Number (rate) of respondents who answered as agree	Mean score ± SD
Question 1	4.20 ± 0.80	26 (86.67%)	4.07 ± 0.75
Question 2	4.00 ± 0.85	23 (76.67%)	3.98 ± 0.72
Question 3	4.53 ± 0.55	30 (100%)	4.46 ± 0.58
Question 4	4.60 ± 0.49	30 (100%)	4.47 ± 0.53
Question 5	4.65 ± 0.47	30 (100%)	4.62 ± 0.51
Question 6	4.22 ± 0.81	25 (83.33%)	4.18 ± 0.71
Question 7	4.42 ± 0.68	28 (93.33%)	4.28 ± 0.64
Question 8	4.00 ± 0.83	22 (73.33%)	3.85 ± 0.80
Question 9	4.67 ± 0.46	30 (100%)	4.45 ± 0.58

Figure.1 Dental Radiology Learning Experience Medical Radiation Technologists' Educational Background Survey (n=85)

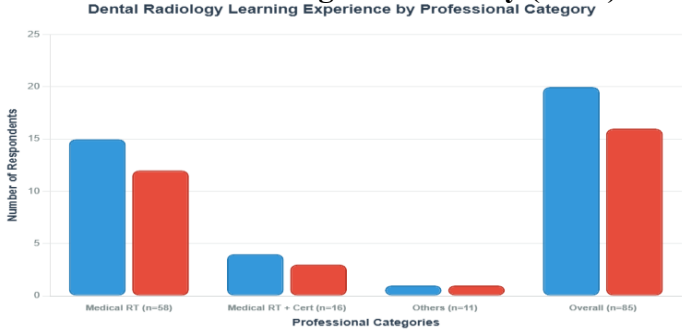
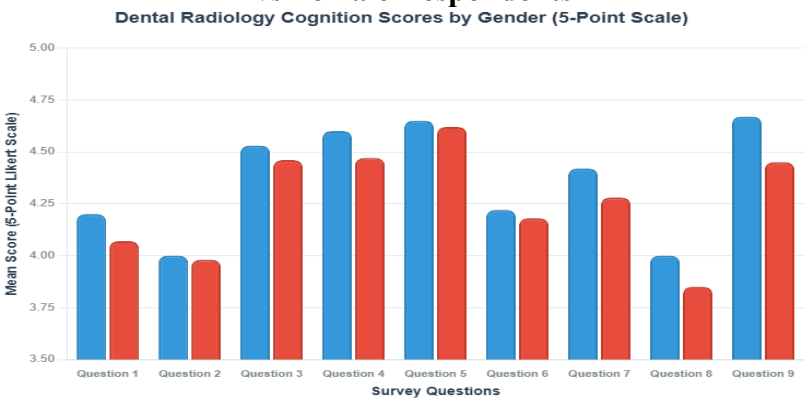


Figure.2 Dental Radiology Cognition Assessment Post-Course Knowledge Comparison: Male vs Female Respondents



DISCUSSION

The modern dental system received its establishment in Taiwan when Japanese operators implemented it during their colonial rule from 1895 to 1945. The dental-related laws and regulations from Taisho 7 period already recognized dental radiology as one of 11 dental professions in 1918. The history of dental radiology stretches back for many years throughout the Taiwanese territory. Taiwan introduced its first dental school together with its first medical radiation school in 1953 and 1965 yet it has not established a complete standardized dental radiology educational framework. Dental radiology stands as an essential element for both dentistry and medical radiology because it continues to hold major importance in dental practices. The teaching of dental radiology through proper courses at Taiwanese medical and dental training institutions remains insufficient for undergraduate students. The national licensure examination for medical radiation technologists started in Taiwan during 1978 as medical radiation technologists established the Medical Radiation Technologists Act in 2000. Medical radiation technologists perform multiple tasks according to the MRTA including diagnostic general radiography, nuclear medicine testing, specialized radiographic imaging and radiotherapy and in-vivo and in-vitro nuclear diagnostics, nuclear therapy, MRI as well as non-ionizing radiation imaging that includes ultrasound for bone density testing. Medical radiation programs provide only limited access to stand-alone dental radiology courses because this subject represents a minor segment of general diagnostic radiography. The regulations for continuing education in Taiwan demand medical professionals including medical radiation technologists to fulfill 120 hours of training every six years where each learning hour counts as a single point(6). Every year each radiation worker must fulfill a minimum requirement of 3 hours of radiation protection training. TCART developed a dental radiology training program which incorporated radiation protection information to fulfill the continuing education regulations. The collected participant feedback about the course served as foundational material for developing standards of dental radiology curriculum at medical radiation schools. The main reason non-medical participants enrolled in the continuing education program was due to interesting course content highlighting the significance of designing engaging topics for training programs in this domain(7,8). The research data reveals male medical radiation technologists hold a slight numerical advantage compared to female technologists throughout Taiwan. Female dental professionals made up the majority of people who joined the course which indicates they display greater interest in radiation protection throughout all dentist radiology practices. The study participants primarily worked in diagnostic radiology followed by radiation therapy and nuclear medicine in accordance with the normal medical radiation worker distribution. The dental procedures field continues its expansion of dental radiology involvement but medical radiation technologists specializing in dental radiology operate at low levels along with dental radiology education courses for students lacking sufficient availability. The dental departments of Taiwanese hospitals and clinics now utilize various X-ray machines for different procedures from periapical to bite-wing and occlusal and panoramic and cephalometric radiographs and advanced

cone-beam computed tomography (CBCT) systems. The rising need for medical radiation technologists who can support dental radiography procedures becomes more pronounced(9). The researchers evaluated dental radiology concept knowledge of participants by sending them a questionnaire after the course completion. The study respondents included mainly medical radiation technologists with radiation protection personnel along with medical staff occupying additional spots. A high proportion of survey participants concurred with the lack of dental radiology courses appearing in both medical radiation school curricula and the continuing education programs. These findings matched prior research. Participants showed overall contentment with the program because it deepened their learning in dental radiology with enhanced radiation protection while making them eager to learn more dental radiology material. The results demonstrate physicians see ongoing dental radiology training as essential because it provides essential professional value. The study results demonstrated male participants giving better evaluations than female participants who assessed their dental radiology learning progress negatively. The course outcomes were more favorable for clinical staff with extensive experience and diagnostic radiology practice as well as medical radiation technologist certification. Previous work experience alongside professional qualifications appear to affect participants' opinions about the application value of the training course. Additional research must explore the specific factors that cause such changes in feedback results. The dental radiology course helped participants understand dental radiology better and improved their understanding of radiation safety yet also demonstrated dental radiology as an occupation choice for medical radiation technologists. The positive assessments from both experienced professionals and men in diagnostic fields together with their peers support the expansion of dental radiology education in continuing development programs. Taiwan needs an extensive dental radiology educational system that beginning students of medical radiation and current technologists should undertake during their academic and practical training phases. This educational system would produce advantages for practitioners and create professional prospects in dental radiology. Sustainable promotional activities will be necessary to advance this system.

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