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Knowledge and Practices of Radiation Protection among Dental Students in Aden, Yemen

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ABSTRACT

Background: Dental radiography is indispensable for diagnosis, but unnecessary exposure to ionizing radiation should be minimized according to ALARA/ALADA principles.
Objective: This study aimed to assess knowledge and practices related to radiation protection among fourth- and fifth-year dental students in Aden, Yemen.
Methods: Analytic cross-sectional survey of fourth- and fifth-year students from public and private dental schools in Aden. A total of 400 students were invited, 270 responded, and 21 incomplete questionnaires were excluded, leaving 249 valid responses (response rate 62.25%). A web-based questionnaire with 15 multiple-choice items covered knowledge and practice domains. Sampling was convenience-based due to logistical constraints. Chi-square tests compared responses by year ($\alpha = 0.05$).
Results: Overall, 79.9% agreed that dental X-rays are harmful. Significant differences (Level 4 vs Level 5) were observed for awareness of collimators/filters (32.3% vs 51.3%; $p = 0.012$), preference not to hold films by hand (58.6% vs 85.3%; $p < 0.001$), recognition that high-speed film reduces dose (40.4% vs 70.7%; $p < 0.001$), and knowledge of operator safety distance (44.4% vs 80.7%; $p < 0.001$). Lead apron use was reported as preferred by 65.1%, but non-availability was the most cited barrier. Most participants (86.3%) intended to adhere to radiation-protection protocols in future practice.
Conclusion: Important gaps persist in specific protection concepts (e.g., rectangular collimation, film holding, and distance rule). Targeted curriculum reinforcement and reliable access to protective resources are needed to translate knowledge into consistent practice.

Keywords: Dental radiography, radiation protection, awareness, dental students, Yemen

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INTRODUCTION

Ionizing radiation exposure is continuous and can come from man-made sources, including medical treatments, as well as naturally occurring sources, such as background radiation (1). Radiographic examinations of the mouth and teeth play an extremely important role in the diagnosis as well as management of various dental conditions. Depending on the patient's clinical problem, dentists use two main techniques, either intraoral radiography or extraoral radiography, for which the latter includes higher doses of radiation (2). All ionizing radiations are harmful and produce biologic changes in living tissues. It causes cell damage primarily through the formation of free radicals. Free radical formation occurs when an X-ray photon ionizes water, the primary component of living cells (3). The deterministic effects are dose dependent, above which the biological damage appears in the body, and the severity of the response is proportional to the dose (4). Although the amount of X-radiation used in dental imaging is small, biologic damage does occur. A statistical association between X-ray exposures in dentistry and increased incidence of salivary gland tumors, thyroid cancer, and intracranial meningioma has been reported (5). There has been no previous study about the attitude of Yemeni dental practitioners toward radiation protection. This study aimed to evaluate the knowledge and awareness toward radiation protection and practice among dental students in Aden City, Yemen.

METHODS

Study Design and Subjects

This cross-sectional study was conducted on a convenience sample of 4th- and 5th-year dental students in Aden City, Yemen. A total of 400 students were invited to participate in a web-based questionnaire that included 14 multiple-choice questions pre-validated and adopted from previous studies (Table 1) (8). Participants as well as a sample of 249 complete responses were obtained for analysis out of the 400 students who were invited, 270 of whom responded, and 21 of whom were excluded due to incomplete surveys.

Ethical Considerations

The University of Science and Technology Ethics Committee granted ethical permission for this study under MEC No. (MEC/AD074), and all participants gave their informed consent before beginning the investigation.

Statistical Analysis

Data were analyzed using SPSS (version 21), with descriptive tests (chi-square) to compare responses by year of study. Statistical significance was set at $p < 0.05$.

RESULTS

Out of 99 participants in this study, 39.8% were 4th-year students and 150 were 5th-year students (60.2% of the participants). The participants were asked if dental x-rays are harmful; overall, 79.9% of the participants agreed that dental x-rays are harmful. Despite 90.9% of 4th-year students agreeing with the harmful effect of dental radiation and 72.7% of 5th-year students supporting the same idea, the difference between the two groups was statistically significant ($P < 0.001$).

Both levels were aware of the x-ray reflection from the rooms' wall and the radiation hazard symbol with no significant difference. The participants were asked if they are aware of the usefulness of collimators and filters in dental radiographs; 43.4% of the 4th-year students replied with no, while 51.3% of the 5th-year students replied with yes. The difference in the responses in the two groups was statistically significant ($P < 0.01$).

Both 4th- and 5th-year students reply correctly when they are asked if the long focal spot film distance reduces the tissue volume exposure of the patient and if digital radiography requires less radiation than conventional radiography, with the effect of the long with no significant difference ($P < 0.348$, $P < 0.716$), respectively. The participants were asked if the high-speed films will reduce the patient exposure; 70.7% of year 5 students replied with yes, while only 40.4% of 4th-year students agreed with the same idea. The difference in the responses in the two groups was statistically significant ($P < 0.000$).

When the participants were asked if they prefer to hold the film with their hand during the exposure process, although 58.6% and 85.3% of the 4th-year and 5th-year students, respectively, reply with "No," 39.4% of the 4th-year students reply with "Yes." The difference in the response between the two groups was significant ($P < 0.000$). The participants were asked about their ability to use the film holder

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devices for taking radiographs on patients; only 44.2% of all participants replied with "Yes."

Although 64% of year 5 students reject the idea of the absolute contraindication of dental radiographs for the pregnant patient, 48.5% of year 4 students agree with the contraindication of using dental radiographs in pregnant patients. The differences in response were statistically significant (P < 0.000). 86.3% of the total participants assured that they will adhere to radiation protection protocol at the time of their future private clinical practice.

Although 65.1% of the participants preferred to regularly use lead aprons, they attributed their lack of use of aprons to the non-availability of aprons, the weight of the aprons, the use of a common apron for all patients, and following a position distance rule in proportions of 62.2%, 15.3%, 9.6%, and 12.9%, respectively. The participants were asked if they exposed patients or their colleagues during the practical requirements in the oral radiology subject; 76.8% of 4th-year students replied they imaged their colleagues, while 54.7% of the 5th-year students replied they imaged patients. The difference in their answers was statistically significant (P<0.000).

The participants were asked about how many times they have to retake the image to get a diagnostic image. 30.9% of the students reply they can get a diagnostic image from the first time, while 57.8% of them will need to retake the image 2-3 times before they get a good image, and 11.2% of the students reply they have to retake it more than 3 times. The difference between their answers was statistically significant (p<0.000).

In spite of 80.7% of the 5th-year students replying with the correct answer regarding the ideal distance an operator should stand while performing a dental radiograph, only 44.4% of the 4th-year students get the correct answer, with a significant difference of P<0.000. Although 78.7% of the students agreed with the importance of minimizing the repetition of x-ray exposure for patients, 57.5% of them stated that they need to retake the image 2-3 times to get an image that they are satisfied with. And the majority of them (57.8%) were in the practical lab working on their colleagues instead of patients.

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Table 1: Comparison of Radiation Protection Knowledge and Practices among Dental Students across Different Education Levels

Knowledge item	Response	Education level		P -value
		Level 4 (n)%	Level 5 (n)%	
Are dental x-rays harmful?	Yes	(90)90.9%	(109)72.7%	0.001
	No	(8)8.1%	(40) 26.7%	
	I don't know	(1) 1%	(1) 0.7%	
Can X-rays be reflected from the walls of a room?	Yes	(82) 82.8%	(109) 72.7%	0.152
	No	(12) 12.1%	(32) 21.3%	
	I don't know	(5) 5.1%	(9) 6%	
Are you aware of the usefulness of collimators and filters in dental radiography?	Yes	(32) 32.3%	(77) 51.3%	0.012
	No	(43) 43.4%	(48) 32%	
	I don't know	(24) 24.2%	(25) 16.7%	
Does long focal spot film distance (FSFD) reduce the tissue volume exposure of the patient?	Yes	(61) 61.6%	(89) 59.3%	0.348
	No	(23) 23.3%	(28) 18.7%	
	I don't know	(15) 15.2%	(33) 22%	
Do high-speed films reduce patient exposure?	Yes	(40) 40.4%	(106) 70.7%	0.000
	No	(23) 23.2%	(27) 18%	
	I don't know	(36) 36.4%	(17) 11.3%	
Do you prefer to hold the film with your hand during exposure?	Yes	(39) 39.4%	(20) 13.3%	0.000
	No	(58) 58.6%	(128) 85.3%	
	I don't know	(2) 2%	(2) 1.3%	
Are you confident in using X-film holding devices for taking intraoral radiographs on patients?	Yes	(39) 39.4%	(71) 47.3%	0.221
	No	(40) 40.4%	(60) 40%	
	I don't know	(20) 20.2%	(19) 12.7%	
Dental radiographs are absolutely contraindicated in pregnant patients?	Yes	(48) 48.5%	(48) 32%	0.000
	No	(33) 33.3%	(96) 64%	
	I don't know	(18) 18.2%	(6) 4%	
Will you adhere to radiation protection protocol at the time of your future private clinical practice?	Yes	(90) 90.9%	(125) 83.3%	0.050
	No	(1) 1%	(12) 8%	
	I don't know	(8) 8.1%	(13) 8.7%	
Do you prefer to regularly use lead aprons?	Yes	(63) 63.6%	(99) 66%	0.317
	No	(24) 24.2%	(26) 17.3%	
	I don't know	(12) 12.1%	(25) 16.7%	
Why did you not use a lead apron?	Non- availability of apron	(61) 61.6%	(94) 62.7%	0.298
	Due to weight the apron	(16) 16.2%	(22) 14.7%	
	Common apron for all	(6) 6.1%	(18) 12%	
	Will follow position distance rule	(16) 16.2%	(16) 10.7%	
During your practical work (study duration), do you take an x-ray image for a patient or your colleague?	Patient	(23) 23.2%	(82) 54.7%	0.000
	Your colleague	(76) 76.8%	(68) 45.3%	
How many times do you have to retake the image to get an image that you are satisfied with?	Can get it from the first time	(21) 21.2%	(56) 37.3%	0.000
	2-3 time	(55) 55.6%	(89) 59.3%	
	More than 3	(23) 23.2%	(5) 3.3%	
Should repetition of x-ray film/exposure be minimized for the patient?	Yes	(86) 86.9%	(110) 73.3%	0.034
	No	(6) 6.1%	(22) 14.7%	
	I don't know	(7) 7.1%	(18) 12%	

*P- value

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DISCUSSION

Radiation protection and safety is an important part of dentistry. To keep both dental professionals and patients safe, the right equipment and techniques must be used to limit their exposure. Even though the radiation exposure during routine procedures is low, patients should still be protected (1, 6, 7).

To protect themselves and their patients, dental students must strictly follow the rule of radiation safety and protection. Also, to keep the workplace safe and healthy, they must follow the rules and suggestions set by radiation protection organizations and regulatory bodies. Therefore, this current study was conducted to assess the knowledge and awareness toward radiation protection among dental students in Aden City, Yemen. This study finds that most of the participants (79.9%) believe in the harmful effect of dental x-rays, and this result was supported by a previous study done by Munnawarulla Khan et al., 2017, where it reported 82.5% of the undergraduate students replied with "yes" for the same question (8), while another study done by Ameera Alabdulwahid in 2021 showed 87% of the undergraduate students did not believe in the harmful effect of the dental x-ray (4).

The participants were asked, “Can X-rays be reflected from the walls of a room?” 76.7% of the participants stated yes.In similar studies conducted by Elfatih Abuelhia et al. (2022) and Munnawarulla Khan et al. (2017), 63% and 67.5% of the undergraduate students respond with "no," respectively (8, 9).

When the participants were asked if they were aware of the usefulness of collimators and filters in dental radiography, although 43.8% of the participants responded yes, there was a significant difference ($P<0.012$) observed between 4th-year and 5th-year participants, suggesting less understanding of protection measures among 4th-year participants. This was the lowest rate of correct answers compared to previous studies done by Munnawarulla Khan et al., 2017, and Amal A. Almohaimede et al., 2020, where 77.5% and 85.2% of the undergraduate students, respectively, responded with yes (8,10).

In this study 58.6% of the participants responded with yes when they were asked if the high-speed film will reduce the patient exposure to radiation; this response was contrary to the results of the previous study conducted by Rathi Rela (2019), where only 2% agreed with the same idea (11).

Regarding the question of if the participants prefer to hold the film with their hand during the exposure process, the majority of the participants (83.1%) respond with no, and this response was consistent with the results of previous studies done by Swapna et al., 2017; Ameera Alabdulwahid, 2021; and Munnawarulla Khan et al., 2017 (4, 8, 12).

In the current study, 44% of participants reported being able to use the x-ray film holding devices for taking intraoral radiographs on patients effectively, whereas in the previous study done by Swapna et al., 82.4% of participants reported difficulty using it (12). This variation might be due to the differences in participant samples or better training and guidance provided to participants beforehand.

Although only 38.9% of the overall participants in this study supported the idea of the absolute contraindication of the use of dental radiographs in pregnant patients, there was a notable difference between responses from fifth-year and fourth-year students, where 64% of fifth-year students disagreed that X-ray use should be absolutely restricted for pregnant patients, while only 33.3% of fourth-year students supported this perspective. This variation in the responses between fourth-year and fifth-year students may be due to variations in their level of knowledge and experience. In spite of this, this finding is similar to the findings of a study conducted by Rela (2019), where 32% of the undergraduate participants considered that it is absolutely contraindicated to take dental radiographs for a pregnant patient (11).

Regarding adherence to the radiation protection protocol, 83% of participants in this study expressed their adherence to following radiation safety standards in the future. This is a higher percentage compared to a previous study conducted by Arnout and Jafar (2014), where only 53.3% reported their commitment, and 40% of participants indicated uncertainty about whether they would adhere to the radiation protection protocol in the future (13). The difference in the result between the two studies may be due to the increase in the awareness and education level on the importance of radiation safety.

Regarding radiation protective measures, our research found a notable disparity between intention and practice. Although 65.1% of participants (99% of Level 5 and 63% of Level 4 respondents) said they would prefer to wear lead aprons on a regular basis,

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the other 20.1% who responded with no referredto the unavailability of the lead aprons at their institutes. This result was opposite to the study done by Munnawarulla Khan et al. (2017) (8), who observed that 30% of the undergraduate students used the lead apron, 37% never used it, and 35% of them said they follow only the distance rule. But similar to Ameera Alabdulwahid, 2021, 88% and 90% of level 4 and level 5 students, respectively, use the lead apron (4).

Although there was a desire for less repeated X-ray exposure (78.7% of all participants), decent X-ray images could not be obtained after 2-3 attempts (57.8% of all participants). This finding is even more alarming, as 57.8% of participants performed radiographic imaging of classmates during the course in oral radiology, thereby increasing the risk of unnecessary radiation.

Despite the fact that 80.7% of fifth-year students were aware of the required safety distance, just 44% of fourth-year students in this study exhibited awareness of it. This is similar to other research by Anushya and Jayaraman (2022), which reported that 85% of their participants maintained a 6-foot distance during X-ray exposure (Anushya P, Jayaraman ML, 2022), and Kirthana Muthu, Shanmugam et al. (2021), which indicated that 61.2% of undergraduate students were aware of the safety distance rule (1,14).

A limitation of this study is that it was conducted among students from only two universities in Aden, which may not adequately represent dental students from other institutions across Yemen. Therefore, the generalizability of the findings to all dental students in the country should be interpreted with caution.

CONCLUSION

This study demonstrates gaps in radiation protection knowledge and practices among Yemeni dental students. Strengthening education in radiation safety and ensuring the availability of protective equipment, such as lead aprons, are essential for safer dental practice.

Conflict of Interest

The authors declare that there is no conflict of interest.

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