



Evaluation of Knowledge, Awareness and Practice of Dental Radiographic Safety Measures among Undergraduates in a Dental Institute: A Questionnaire Based Cross-Sectional Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Radiation is energy given by matter in the form of rays or high-speed particles. Radiology uses imaging technology to diagnose and treat disease. Though radiology is one of the major aspects in medical and dental field, it has its own set of advantages and disadvantages. The present study was conducted with the objective of evaluating the knowledge, awareness and practice of dental radiographic safety measures among undergraduates in a dental institute and to educate all those working with radiation and are unaware of the risks that might affect them later.

Materials and Methods: This study was conducted on 300 participants that involved dental students belonging to 3rd year, final year and those who worked as interns. A Questionnaire was prepared and distributed. It had multiple choice questions regarding demographic information about the patient, about the X-ray machines used by them, and the safety measures they take.

Results: The results revealed that out of 300 dental students who participated in the questionnaire 69.68% were females and 30.32% were male, aged between 20 to 25years. 100 dental students each from 3rd year, final year and internship answered the questionnaire and it is observed that only 25.48% of thirds years are aware of the radiation hazards. In the case of final years, only 33.16% of them answered correctly and only 41.76% of interns gave correct responses.

Conclusion: Not even 50% of the participants answered correctly which means the students have poor knowledge about radiation hazards. Radiographic safety measures and precautions should be taken to prevent the harmful effects of unwanted radiation to cause various health problems.

Keywords: Radiation; X rays; radiology; questionnaire; knowledge; awareness.

1. INTRODUCTION

“The X- rays are a form of ionizing radiation causing biological effects on tissues by producing free radicals and damaging DNA strands. Since the discovery of X-rays in the year 1895, radiological examination has become an integral part of patient management in the field of dentistry” [1].

“Radiographs are an important tool for diagnosis and treatment planning. Radiographs are the most frequent diagnostic aid compared to the medical field so radiation hazard becomes an important public health concern. Even though such exposure is less, it is critical to reduce the exposure to the dental personnel and patients in order to prevent the harmful effects of radiation” [2].

A single periapical digital radiograph results in an exposure of 0.005 to 0.01 mSv (millisieverts), while a single bitewing digital radiograph causes an exposure of 0.005 mSv. Extraoral radiographs, such as panoramic or orthopantomogram (OPG), cephalometric, and cone beam computed tomography (CBCT), result in exposures of 0.007 to 0.024 mSv, 0.007 to 0.025 mSv, and 0.08 to 0.2 mSv, respectively.

Intraoral radiographs such as bitewing and periapical have the lowest exposure and are quickest, while CBCT has the highest exposure and takes longer. All dental radiographs involve

minimal radiation when compared to medical imaging. However, CBCT requires more care such as minimizing use and careful case selection due to its higher radiation dose. Dentists typically limit the frequency of higher dose radiographic examination like CBCT and panoramic radiographs, and they follow strict safety protocols to reduce risks, including the use of protective barriers and limiting unnecessary exposure.

“The dental radiograph should be prescribed only for a patient when the benefit of disease detection outweighs the risk of damage from radiation. X-rays are harmful to living tissues and their intensity is sufficient to cause cancer, leukemia and genetic damage. The dentist needs to be aware of radiation protection measures and the radiation dosage received daily in order to protect themselves and their patients from the harmful effects of radiation” [3].

“The International Commission on Radiological Protection (ICRP) began to develop the Risk/benefit concept in 1977, this concept recommended that all patient exposures must be justified and kept to follow the As Low As Reasonably Achievable (ALARA) principle. The aim of ALARA principle in dental radiology is aimed at justification, selection criteria, equipment, and quality assurance” [4].

“The dentist should be aware of different radiation protective methods as well as the daily

received radiation dosage” [5]. The purpose of this research was to evaluate the knowledge, awareness and practice of dental radiographic safety measures among the undergraduate students working with radiation, to increase their awareness and promoting the proper safety practices in handling radiographic equipment.

2. MATERIALS AND METHODS

2.1 Subjects and Methods

A questionnaire survey was performed on 300 subjects after obtaining institutional ethical clearance from Institutional Ethics Committee, Vishnu dental College, Bhimavaram. The certificate number is IECVDC/2021/UG01/OMR/Q/57 and was approved on 26-02-2021. This study is based upon previous research, which majorly assessed the knowledge of dental practitioners, with a few studies comparing the knowledge between undergraduates and postgraduates. However, this study focuses purely on the knowledge and perceptions of radiological safety measures among undergraduate students. The source of data included undergraduate students by using convenience sampling.

Out of 300 subjects, 100 were third year students, 100 were final year students, and 100 were interns of a dental institute affiliated with NTR University of Health Sciences (NTRUHS). A questionnaire which enclosed 25 structured questions was distributed. All the Individuals who were participating in the study were assured about the anonymous processing of the questionnaire, and were explained about the purpose of the above research. The collected Information was subjected to statistical analysis.

The questionnaire comprises of the following sections:

1. Demographic characteristics of students which includes age, sex, Year of studying.
2. Usage of Radiographic equipment and accessories which includes type of film, film

holding device, Type of collimators, exposure parameters etc.

3. Radiation protection for patient and personnel which includes position distance rule, film badges, usage of lead aprons and thyroid collars and lead partitions.

2.2 Statistical Analysis

Statistical analysis was performed using SPSS software version 21.0 and analysis was carried out using Descriptive statistics and Chi-square test. The p – value > 0.05 was not considered statistically significant.

3. RESULTS

The results revealed that among the students who participated, 69.68% were female and 30.32% were male, all aged between 20 and 25 years. 100 dental students each from third year, final year and internship answered the questionnaire. The Table 1 provides the demographic data of the students who participated. The Table 2 shows the questions and percentage of students who answered correctly from each year and also the answers chosen by the percentage of students in total to each given question.

The knowledge regarding radiation safety measures was less among third year students when compared to final year and interns. Among the participants, the third year students who were newly exposed to dental radiographic practice had less knowledge when compared to the final year and interns who were already familiar with the regular dental radiographic practice.

There is a positive correlation between knowledge and practice regarding dental radiographic safety. Students with a strong understanding of safety measures are more likely to effectively follow practices that minimize radiation exposure to both patients and themselves. Adequate knowledge leads to proper adherence to safety protocols.

Table 1. Students demographic data

Students demographic variable		Number of students	Percentage of students
Age	20 -25 years	300	100 %
Gender	Males	91	30.32%
	Females	209	69.68%
Year of study	Third years	100	33.33%
	Final years	100	33.33%
	Interns	100	33.33%

Table 2. Questionnaire results

% of responses	Options	Questions	Correct Answers		
			3rd yr	4th yr	Interns
27.42%	Cylindrical	Shape of collimator used for exposing X rays ?	22%	37%	41%
66.45%	Rectangular				
6.13%	Unaware				
27.74%	E speed	Speed of the film used to take radiograph ?	23%	37%	40%
46.13%	F speed				
7.74%	D speed				
18.39%	Unaware				
65.48%	Digital	Type of radiographic receptor used ?	32%	34%	34%
27.42%	Conventional				
7.10%	Unaware				
82.58%	60-70 kVp	Tube voltage of intraoral radiographic machine ?	32%	33%	35%
8.39%	> 90 kVp				
9.03%	Unaware				
40.97%	0.5-0.8 secs	Exposure time for intraoral radiographic machine ?	22%	24%	54%
48.71%	1.5-2 secs				
6.45%	3 secs				
3.87%	4 secs				
75.16%	Using film holder	What do you prefer while taking IOPA ?	19%	26%	55%
13.55%	Patient holding the film				
11.29%	Holding it themselves				
21.29%	Only operator	Do you wear lead apron during exposure ?	25%	25%	50%
34.52%	Only patient				
44.19%	Both				
95.16%	Yes	Do you take informed consent of the patient before acquiring radiograph ?	33%	33%	34%
4.84%	No				
50.97%	Yes	Do you stand behind the lead shield when not using lead apron ?	15%	31%	54%
49.03%	No				
90%	Yes	Do you get the radiograph equipment checked periodically ?	32%	34%	34%
10%	No				
61.61%	Yes	Do X-rays reflect from walls ?	19%	38%	44%
38.39%	No				
89.68%	Yes	High radiation doses lead to cancer ?	31%	34%	35%
3.87%	No				
6.45%	Unaware				
87.74%	Yes	Should ideal position and distance be followed while taking radiographs ?	31%	34%	35%
5.81%	No				
6.45%	Unaware				

% of responses	Options	Questions	Correct Answers		
			3rd yr	4th yr	Interns
84.52%	Yes	Does digital radiography requires less exposure than conventional ?	32%	33%	35%
6.45%	No				
9.03%	Unaware				
52.26%	Yes	Radiographs are absolutely contraindicated for pregnant patients ?	7%	46%	47%
36.13%	No				
11.61%	Unaware				
80%	Yes	Can X-rays be reflected from the body of the subject?	28%	34%	39%
8.39%	No				
11.61%	Unaware				
82.26%	Yes	Children are at a higher risk of harm from X-rays than adults?	29%	33%	37%
5.48%	No				
12.26%	Unaware				
8.06%	Lead aprons	Mark the various options to reduce radiation exposure to patient that you are aware of?	31%	34%	35%
2.26%	Lead shields				
3.87%	Exposure time				
85.81%	All of the above				
88.39%	Yes	ALARA principle should be applied while taking radiographs?	34%	27%	39%
3.87%	No				
7.74%	Unaware				
70.65%	Very confident	How confident are you in your knowledge of radiation hazards and their protection?	18%	32%	50%
18.39%	Less confident				
10.97%	Unaware				
49.35%	Yes	Are you aware of NCRP and AERB recommendation?	29%	30%	41%
50.65%	No				
89.03%	Yes	Personal monitoring badges should be worn by the operator?	32%	33%	35%
10.97%	No				
13.23%	Testicles	Which among the following is the most radio resistant organ?	10%	28%	62%
49.03%	Muscles				
10%	Lungs				
27.74%	Unaware				
88.71%	Yes	Are you aware of the protocol for radiographic waste management?	30%	34%	36%
11.29%	No				
24.19%	Lectures	Which among the following you think will be the most appropriate way of awareness of	23%	35%	42%
32%	Workshops or Tutorials	radiation protection and hazards?			
11.94%	Case studies				
13.55%	Learning modules				

The test results did not reveal statistically significant differences between the responses of third-year students, fourth-year students, and interns ($p > 0.05$).

4. DISCUSSION

The doctor's awareness and knowledge level regarding safety and reducing dose in terms of patients have been proved to be very important. In this study, knowledge based questions were asked in the form of a questionnaire, such as on ALARA principle, dose limits and radiation protection.

Bio monitoring studies counsel that exposure to low level radiation like that of dental radiography might not be an element in causing semi permanent body harm, however might end in localised toxicity within the irradiated region Of the mouth, with no semi permanent damage [6].

A study conducted among students in Medical University of Warsaw revealed that radiation awareness among dentists, radiographers and students is inadequate when compared to dentists who had completed radiation protection training. At international level, International Commission for Radiological Protection (ICRP), and at national level, National Commission for Radiological Protection (NCRP) and Atomic Energy Regulatory Board (AERB) do the regulation for radiation protection. The results were observed according to the above concept and found that the knowledge of dental students regarding the authorities such as ICRP, NCRP, and AERB are observed to be as high as 29% of 3rd years, 30% of 4th years and 41% of interns are aware about the above topics. According to the article named "A scoping review on dental students knowledge and awareness on radiation protection" ranged between 5- 54% [7].

When analyzing the exposure parameters for intra oral radiographic equipment it was found that 48% (third years) 33.5% (final years) and 18.5% (interns) were having no idea about at what kVp their equipment was working. The results are in agreement with study by Swarna Yerebairapura. et al. [4]. but contradictory to the recent study done by Bhavana Agarawal., et al. [8]. The lack of knowledge about kilovoltage peak (kVp) can be attributed to the fact that dental x-ray machines in India are having fixed kVp and milliampere (mA) generally operating at 70 kVp and only exposure time is variable.

In our study, we found that a rectangular collimator was used only by 22% (third years) , 37% (final years) and 41% (interns). The results were in opposition with the Eskandarlou., et al. [9] Belgium 2004 (6%) [10] Turkey 2005 (5.5%) [11] and Canada 1994 (8%) [12]. Even though the percentage of participants using rectangular collimators is more compared to other studies, the dentists and radiographers should be informed about the use of a PID (rectangular position indicating device) attached to the radiographic tube housing, which decreases the dose by 50%.

For intraoral radiography, the most commonly used intraoral film in dental practice is E-speed which results in a dose reduction of 40 – 50%, when compared with D-speed film. The final result of this study showed that E speed radiographic film is used by 80% and D-film by 3% of the respondents. This is in agreement with the data presented in Kaviani et al. [13] who reported about 80% use of E-Speed intraoral films in private dental clinics. In the present study, only 18% were not aware of the speed of films, the results are not accordance to the study conducted by Ilguy. et al. [11] who reported that 65.8% of dental practitioners were not aware of film which indicates that the participants in the present study had better knowledge compared to other studies. Among the responders of this study, only 2% of the interns used F Speed films. Students should have been encouraged to shift to F-speed film from D and E speed films to reduce 20% radiation dose to patients.

Digital intraoral receptors need less radiation dose to produce images as compared to conventional films. The present study shows 32% (third years) 34% (final years) and 34% (interns) are using digital sensors. A study from Spain by Alcaraz M. et al. [14] reported that 19.3% dentists chose digital radiography with an annual increase of 4%. The results (27.3% digital receptors) were in agreement with two reports from a study from Belgian by Jacobs R (2004) [10] for using digital intraoral imaging (34% and 38%, respectively). It is a fundamental right of every patient to be informed before any radiograph. Their consent is very necessary and according to our study majority of the students ask the patients for their consent. 33% of 3rd years, 33% of 4th years and 34% of interns were aware that an informed consent has to be taken from the patient. The study conducted in Port

Harcourt says that 88.3% of patients reported that their consent was not taken [15].

In the present study, the percentage of dentists that always wore a lead apron was 25% (third years) 25% (final years) and 50% (interns) which is a good increase compared to the study carried out by R. Jacobs., et al. In Belgian [10] only 12% of the dentists were seen to be wearing lead aprons while working on x-ray units. Though not exactly, the number of people who were not wearing lead aprons would have a tendency that the radiation exposure due to x-ray machines is very less, so fewer dentists are using lead aprons and thyroid collars while exposed.

Direct exposure of dentists and patients with the radiation source should be controlled as much as possible. Lead aprons are the best radiation barriers reducing the harmful effects of exposure. This study reveals that a non-significant number of respondents use lead aprons in their dental radiological practice. A similar outcome was seen in a research conducted on Undergraduate and postgraduate Pakistani students [6].

There is evidence that radiation exposure to the thyroid during pregnancy is associated with low birth weight. The present study showed that 50% (third years) 28% (final years) and 22% (interns) had reported that they will take radiographs for pregnant women, where pregnant women should never undergo exposure to radiographs during first and the third trimesters but can get radiographs in the second trimester if they have to undergo any of the procedures like dental extractions and root canal treatment to assess the peri apical areas. The study revealed that significant positive numbers agree that dental radiography is not completely contraindicated in pregnant patients. A similar outcome was observed in a study conducted on Egyptian students [16]. Since all precautions should be taken to deduct radiation exposure, protective thyroid collars and aprons should be used whenever possible [3].

The important principle for radiation protection is ALARA. This principle defines how to take a good radiographic image with minimum radiation. The knowledge of dental students regarding the radiation protection principle according to the study shows that 34% of the third year, 27% of final years and 39% of interns happen to be aware of the principle for radiation protection and most of them are unaware. But according an Article published in Annals of SBV, the

percentage of the knowledge varies from 37.4 to 70% [7].

Radiographic waste management also plays an important role in the further complication if not managed correctly. We have to note that it is very essential to make students know about it as the present study shows 70% (third year) 21% (final year) 9% (interns) told that they are not aware of radiographic waste management. Similarly, a total of 12% of participants of a study conducted in Chandigarh responded that they were unaware of the color-coding system for waste disposal [17].

Film holders should be used at all times for alignment of x-ray film, x-ray source and subject. The main function is to prevent the unnecessary retake of radiographs and thus aids in reduced exposure. 33% (third years) 33% (final years) and 34% (interns) reported using film holders. Most of the time, 55% (third years) 26% (final years) and 19% (interns) asked their patients to hold the films inside the mouth with their fingers for almost every exposure. A surprising finding was that 48% (third years) 37% (final years) and 14% (interns) held the film themselves while the radiograph was being taken of the patient in accordance to study carried by Swarna Yerbairapura et al. [4] where 13% of dentists held the film themselves. But the clinicians and radiographers might risk exposure of radiation knowingly or unknowingly and either willingly or unwillingly, it may be due to noncompliance of patients, or uncooperative patients. Sometimes they risk exposure to get best results or to reduce the second exposure or sometimes hurry in doing the dental treatments which make them less concerned regarding the radiation.

The results of the present study shows that about 33% (third years) 33% (final years) and 34% (interns) know that they have to maintain the ideal distance of six feet if there is lack of provision of lead apron which concur with the results of studies carried out by Kaviani., et al. [13]. Majority of the clinics did not have a protective barrier due to unavailability of lead partitions in there clinical setup (70.3%). Only 30.8% of the dentists were found following the position - distance rule. Students (90%) and radiographers (42.5%) due to availability of lead partitions in their institutions stand behind the lead partitions which indicate that dental professionals need to update knowledge regarding radiation protection. Most of the participants (95%) show an immense response

as yes to the question that they will adhere to radiation protection protocol in future. Hope these may overcome pitfalls regarding the lack of knowledge on radiation safety in future.

Although statistically significant results were not obtained, there were observable variations in knowledge and practices related to dental radiographic safety measures among the groups. For example, a higher percentage of interns demonstrated safer practices, such as wearing lead aprons and standing behind lead shields during exposure, compared to third year and fourth year students. These trends suggest that with a larger sample size, the differences may become statistically significant.

5. LIMITATIONS

The study was conducted among a group of students having varied disparities in knowledge and as well as clinical exposure. So it is understandable why the third year students have performed poorly in questioning the answers correctly than fourth year students and interns.

6. SUMMARY

This questionnaire study was conducted to evaluate the knowledge and awareness of the undergraduate BDS students about radiation hazards during the regular dental radiographic practice. The study includes 300 undergraduate students of third year, final year and interns who were willing to participate in the study. A questionnaire with 25 structured questions was distributed among the dental students in whose curriculum dental radiographic practice was included. All the individuals who were participating in the study were assured about the anonymous processing of the questionnaire, The responses were recorded and were subjected to statistical analysis. The obtained results showed that the knowledge about radiation safety measures among third year students was lacking when compared to final years and interns

7. CONCLUSION

It is recommended that the curriculum of third year students should be improved so that the third year students who are new to the regular dental radiographic practice will be well aware of the radiographic safety measures and precautions that should be taken to prevent the harmful effects of unwanted radiation to cause various health problems.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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