



## Evaluation of Knowledge and Awareness on Practice of Dental Radiographic Safety Measures in West Godavari District, India –A Questionnaire Based Cross-Sectional Study

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### Abstract

**Context:** With various technological advancements in oral and maxillofacial radiology, the prime source of radiation being ionizing causes biological effects on tissues. To prevent and reduce such harmful effects, it is necessary to have a thorough knowledge about the exposure parameters and radiation protection measures.

**Aims:** To evaluate the knowledge and awareness towards radiation hazards and radiation protection techniques among dental practitioners, radiographers and dental students in west Godavari district, India.

**Settings and Design:** The study was carried out among 120 subjects comprising of dental practitioners, radiographers, and dental students in West Godavari district, India using convenience sampling.

**Methods and Material:** A questionnaire comprising of 25 structured questions were distributed and data was collected.

**Statistical Analysis:** SPSS software analysis using Kruskal Wallis test, Tukey's post hoc test.

**Results:** The respondent's knowledge regarding kilovoltage peak settings of their equipments was limited in dentists and radiographers. Very few percentages used rectangular collimator and 22.5% dentists, 25% students and 25% radiographers were unaware of film speed they are using. 25% of dentist and radiographers held the film themselves while taking radiograph. Lead aprons were not worn by 60% of dentist, 80% of dental students and 72% radiographers on themselves during exposure and none of them used thyroid collars.

**Conclusion:** The study revealed that the radiographers and dental students had better knowledge compared to dental practitioners in this study population, which highlights the need for training and recertification programs like continuing dental educational to improve the awareness and knowledge on effective radiation protection.

**Keywords:** Kilo Voltage Peak; Collimation; Radiation Safety and Protection; Lead Apron; Radiographic Film

### Introduction

A radiograph serves as prime source of investigation and helps us to arrive at a proper diagnosis. Even with various technological advancements in oral and maxillofacial radiology, the prime source of radiation being ionizing causes biological effects on tissues via the production of free radicals [1]. Radiation acts on living systems through direct and indirect effects. In direct effects, biologic molecules absorb energy from ionizing radiation, whereas indirect effects show actions by interacting with water and organic mol-

ecules and produces unstable free radical [2]. These free radicals play an important role in producing molecular changes in the DNA strands and further cause damage to the living tissues. To prevent and reduce such harmful effects, it is necessary to have a thorough knowledge about the exposure parameters and radiation protection measures.

Although in dentistry radiographs are mostly used for diagnostic purposes where only minimal radiation is used, they entail stochastic effects, that is, an all-or-none phenomenon. So, it is

mandatory to reduce the harmful effects of radiation exposure on both the radiographers as well as on the patients. During under and post-graduation studies in dentistry, students are exposed to radiation during radiographic procedures and in dental practices usually the practicing dentist gets exposed to radiation when performing radiographic procedure. Even though such radiation exposures are less, it is critical to reduce the radiation exposure for practicing dentists and dental students, in order to prevent the harmful effects of radiation.

The dental radiographs should be prescribed only when benefit of disease detection outweighs the risk of damage from radiation exposure and there is necessity following the ALARA principle. Good radiographic procedure comprises, use of collimators and film holding devices, use of lead apron and thyroid collar, knowledge on exposure parameters, following position distance rule in a lead partitioned radiographic room [3]. Even after having knowledge, negligence sometimes leads to unwanted radiation effect.

On reviewing the literature, the number of studies regarding the extent of radiation protection and safety measures which are followed in West Godavari district, India are less, hence there is an urge to expand the knowledge of various radiation safety and protection measures in practitioners, radiographers and dental students by means of a questionnaire study.

### Subjects and Methods

A questionnaire survey was performed on 120 subjects after obtaining institutional ethical clearance and the source of data includes selected private dental practitioners, dental students and radiographers (technicians) working in diagnostic centers by using convenience sampling. Dental practitioners, radiographers and dental students who are willing to participate in the study were included. Dental students in whose curriculum radiology was not included, individuals not interested in the study and incomplete questionnaires were excluded from the study.

Out of 120 subjects 40 were practicing dentists, 40 were dental students and 40 were radiographers working in diagnostic centres in various places of West Godavari district, India. A questionnaire which encloses 25 structured questions was distributed by visiting each dental clinic among private dental practitioners, undergraduate and postgraduate students in a dental college and radiographers working in diagnostic centres in various places of West Godavari district, India. 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 dentists which includes age, sex, work experience, year of graduation.
- (2) Usage of Radiographic equipment and accessories which includes type of film, film holding devices, type of collimators, exposure parameters
- (3) Radiation protection for patient and personal which includes position distance rule, film badges, usage of lead aprons and thyroid collars and lead partitions.

Statistical analysis was performed using SPSS software and analysis was carried out using Kruskal Wallis test, Tukey’s post hoc test.

### Results

The results showed that out of 120 responders, 72 were male and 48 were females and on analysis of demographic data, based on age, 50% of respondents were below the age of 35 years and 50% were above 35 years of age and 70% participants responded that they were using radiographic machine for more than 5years and take more than 30 radiographs per month (Table 1).

Questions	Criteria	Clinicians	Students	Radiographers
Gender	Male	29%	13%	30%
	Female	11%	27%	10%
Age	Below 30 years	15%	38%	19%
	Above 30 years	25%	2%	21%
How long using radiographic machine	< 5years	30.5%	37.5%	10%
	> 5years	55%	47.5%	90%
No of exposures per month	20 - 30	43.5%	48.5%	33.5%
	> 30	47.5%	52.5%	67.5%

**Table 1:** Classification of the participants based on age, gender, how long using radiographic machine, No exposures per month.

**Exposure parameters**

On assessing the knowledge regarding the exposure parameters like kilo voltage potential, majority of dental practitioners around 63% (n = 25) out of 40 reported that their dental X-ray machines operate between 60 and 70 kilo voltage peak (Kvp) and remaining 37% (n = 15) were having no idea about at what Kvp their equipment was working.

In case of students 92% (n = 36) out of 40 dental students reported that their dental X-ray machines operate between 60 and 70 kilo voltage peak (Kvp) and remaining 8% (n = 4) were having no idea about at what Kvp their equipment was working in their institute.

In case of radiographers 12% (n = 7) out of 40 radiographers reported that their dental X-ray unit operate between 60 and 70 Kvp and 57.5% (n = 23) out of 40 radiographers reported that their dental X-ray machines operate more than 90 kilo voltage peak (kVp) and remaining 25% (n = 10) were having no idea about at what kVp their equipment was working. Based on the obtained results it shows a significant statistical difference (p < 0.03) between knowledge level of dentists and radiographers over students, who had less knowledge regarding the working kVp of the intraoral radiographic machine (Table 2).

Questions	Responses	Clinicians	Students	Radiographers
Type of collimator	Rectangular	20.0%	12.5%	27.5%
	Cylindrical	79.8%	87.5%	72.5%
	Unaware	2%	2%	2%
Speed of the film	E speed	75%	73%	85%
	F speed	2.5%	2%	2.5%
	Unaware	22.5%	25%	25%
Type of radiographic receptors	Conventional	48.5%	70%	25%
	Digital	27.5%	23%	17.5%
	Both	20%	7%	57.5%
Tube voltage of intraoral radiographic machine	60 -70 kvp	63%	92%	12%
	>90 kvp	-	-	57.5%
	Unaware	37%	8%	25%
Exposure time for intraoral radiographic machine	0.5-0.8sec	64%	97.5%	35%
	>1.5 sec	34.5%	2.5%	65%
Exposure time for orthopantomogram	10 sec	0	74%	55%
	15 sec	0	25%	30%
	Not available	100%	0	15%
While taking IOPA on patient	Using film holders	25%	17.5%	10%
	Ask the patient to hold the film	50%	82.5%	60%
	Holding themselves	25%	1%	30%
Did you wear Lead apron during exposure	Lead apron on themselves	40.0%	20.0%	28%
	Lead apron on patient	20%	37.5%	27.5%

**Table 2:** Table showing the Questions given to the participant and their responses group.

Regarding exposure time, 70 % of participants operate their x-ray unit at exposure time between 0.5 - 0.8 sec and in case of orthopantomogram 10 - 15 sec and majority of the participants around 27.5% (n = 14) are unaware of exposure time of their x-ray unit the main reason behind these is fixed exposure time in the dental x-ray unit.

**Collimation**

In the present study only 20 % (n = 8) dental practitioners were using the rectangular collimator and 79.8% (n = 32) were using the cylindrical type of collimator. Among 40 students not more than 12.5 % (n = 4) were using rectangular collimator whereas majority of students 87.5% (n = 34) reported use of cylindrical type of collimator in their college and 2 % (n = 1) were not aware of type of collimator used.

Among 40 radiographers only 27.5% (n = 14) were using the rectangular collimator, whereas 72.5% (n = 26) were using the cylindrical type of collimator. A significant statistical difference was obtained (p < 0.03) with in the groups, regarding type of collimator used (Table 2).

**Radiographic film**

On surveying the type of films used by dental practitioners, 75 % (n = 28) of them were using E speed films and 2.5% (n = 3) were using F speed films and remaining 22.5% (n = 9) were unaware of which type of films they were using. While taking type of radiography in to consideration it showed that 48.5% (n = 19) of 40 dental practitioners preferred the conventional radiography, 27.5% (n = 16) of 40 were using digital radiography and 24 % (n = 9) are using both conventional and digital.

Among 40 students 73%(n = 29) gave information that they were using E speed film and 2% (n = 1) were using F speed film and remaining 25 % (n = 10) were unaware of type of film they were using and 70% (n = 30) of 40 students preferred conventional radiography, 23%(n = 8) students replied that they were using digital radiography and only 7%(n = 2) students replied that they were using both conventional and digital in their institute.

Among 40 radiographers 85% (n = 34) gave information that they were using E speed film and 2.5% (n = 1) were using F speed film and remaining 13.5% (n = 5) were unaware of type of film they were using and 25% (n = 10) of 40 radiographers preferred conventional radiography, 17.5% (n = 7) radiographers replied that they were using digital radiography and only 57.5% (n = 22) radiographers replied that they were using both conventional and digital in their diagnostic center (Table 2).

**Film holders**

The majority of dental practitioners around (75%) (n = 30) Stated that they were not using film holders and around 25% (n = 10) were using film holders. But, 50% (n = 21) of the dental practitioners asked their patients to hold the films inside the mouth with their fingers for almost every exposure. A surprising finding was that 25% (n = 12) of the dentists held the film themselves while the radiograph was being taken on the patient.

Out of 40 students majority of them 82.5 % (n = 32) reported that they asked the patients to hold the films inside the mouth with their fingers and 17.5 % (n = 6) of students were using film holder.

Almost 60% (n = 24) of radiographers asked their patients to hold the films inside the mouth with their fingers for almost ev-

ery exposure, 10% (n = 4) reported using film holders and 30% (n = 12) of the radiographers hold the film themselves while taking radiograph. A significant difference with p value of < 0.03 is seen which shows that fair percentage of clinicians have knowledge of film holder usage during exposure when compared to students and radiographers, but strange thing we noticed is remaining 30% of clinicians and radiographers hold film themselves during exposure which is an area of concern (Table 2).

### Radiographic protection for patient and personnel

Almost 60.0% (n = 24) of 40 dental practitioners did not wear lead aprons and thyroid collar on themselves during radiographic exposure and 80% (n = 32) of the dental practitioners did not wear lead apron and thyroid collar for patient protection.

Almost 80.0% (n = 32) of 40 dental students did not wear the lead aprons and thyroid collar on themselves during radiographic exposure and 62.5% (n = 24) of the dental students did not wear lead apron and thyroid collar for patient protection.

In case of radiographers 28% (n = 11) of 40 revealed that use the lead apron and thyroid collar on themselves during radiographic exposure and 27.5% (n = 10) of the radiographers use lead apron and thyroid collar for patient protection. The result shows that use of lead apron and thyroid collar was minimal (Table 2).

Only 28% (n = 11) of 40 dental practitioners took radiographs for pregnant woman and in 80 % (32) of clinicians had taken using lead apron as a protection. In case of students 42% (n = 16) of 40 had reported that they will take radiographs for pregnant woman and 80% (n = 32) of students had taken using both lead apron and thyroid collar as protection.

In case of radiographers 50% (n = 20) had reported that they will took radiographs for pregnant woman and 58 % (n = 23) of taking radiographs after asking the patients to wear the lead apron in case of pregnant women (Table 2).

### Position Distance Rule

Out of 40 dental practitioner around 30% (n = 12) always stood next to the patient during radiographic exposure by holding the film in the patient's mouth, and 50% (n = 20) of clinicians stand inside the room at distance of 6feet from the central ray.

In case of students 55% (n = 22) of 40 reported that they stand outside the room at distance of 6feet from the central ray behind

the lead partitions during intra oral radiographic exposure.

In case of radiographers 52.5% (n = 21) of 40 reported that they stand behind lead barrier at distance of 8 feet from the central ray (Table 2).

### Film badges

Among the participants, 10% (n = 4) dental practitioners, 25% (n = 10) dental students, and 87% (n = 16) radiographers were using radiation monitoring devices such as film badges.

### Discussion

Although the radiation exposure encountered in dentistry is minimal, its harmful effects cannot be ruled out [4]. On the other hand, the literature had reported the noncompliance of dental practitioners with these radiation protection guidelines worldwide. There is a definite need to identify the pitfalls hindering the effective implementation of radiation protection guidelines among dental professionals and radiographers.

This will overlay the way for the implementation of radiation protection practices for the benefit of both patients and operator.

There is definite scarcity of literature exploring knowledge of radiation protection among dental professionals, students and radiographers in the Indian context [4].

Hence, the present study was conducted to explore knowledge regarding radiation protection among dental practitioners, radiographers and dental students to perceive the spread of awareness, willingness to gain and implement knowledge about radiation hazards and protection.

Thus, present survey highlights the lack of knowledge regarding various aspects of dental radiography and radiation protection among the dental practitioners, radiographers and dental students.

When analyzing the exposure parameters for intraoral radiographic equipment it was found that 37% (dental professionals) 8% (students) and 42% (radiographers) were having no idea about at what kVp their equipment was working the results are in accordance with study by Swarna Yerebairapura., *et al.* [5] but contradictory to the recent study done by Bhavana Agarawal., *et al* [10]. This lack of awareness about kvp may be attributed to the fact that contemporary dental X-ray machines in India are having

fixed kvp and miliampere (ma) generally operating at 70 kvp and the only variable factor in dental X ray unit is the exposure time [10].

The size and shape of the X-ray beam have been reported as two of the most important factors in determining the dose to the patient in dental radiology [5]. For periapical radiography, restriction of the beam was more with rectangular collimator compared to conical [5]. The tissue area exposed with rectangular collimator reduces the dose of about 5 times than the area exposed with the circular cone, but unfortunately in our study rectangular collimator was used only by 20 % of the dental practitioners and 27.5% of radiographers and 10% of students. The results were contradictory with the Eskandarlou, *et al.* [6], Belgium 2004 (6%) [7]. Turkey 2005 (5.5%) [8] and Canada 1994 (8%) [9]. Even though the percentage of participants regarding the usage of rectangular collimators are more compared to other studies the dentists and radiographers should be informed about the use of a rectangular position indicating device (PID) attached to the radiographic tube housing, which reduces the effective dose by almost 50%.

For intraoral radiography, the most commonly used intra-oral film in dental practice is E-speed which results in a dose reduction of 40 - 50%, when compared with D-speed film. The results of present study showed that E-speed radiographic film is used exclusively by 75% of respondents and D-speed film by 2%. This has been in good agreement with the data presented by Kaviani, *et al.* (2006) [11] who reported about 70% use of E-Speed intraoral films in private dental clinics. In the present study, 22.5% of the dental practitioners, 25% of students were not aware of the speed of films, the results are not accordance to the study conducted by Ilguy, *et al.* [8], 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 but they need to be aware of speed of the film because faster speed films reduce about 20% radiation dose to their patients.

Among the respondents of this study, only 2% of the dental practitioners used F Speed films. Dentists should have been encouraged to shift from D and E speed films to the F-speed film to reduce 20% radiation dose to their patients.

It has been determined that digital imaging for intraoral radiography requires about half the exposure of E-speed film. The digital intraoral receptors require less radiation dose to produce images as

compared to conventional films. The present study shows 27.3% of dentists using the digital receptors and 48.5% while remaining still adheres to analog receptor system and 24% were using both conventional and digital. A study from Spain by Alcaraz M., *et al.* [12] reported that 19.3% dentists preferred digital radiography with yearly increase of 4%. The results (27.3% digital receptors) were in accordance with two reports from a study from Belgian by Jacobs R (2004) [7] for using digital intraoral imaging (34% and 38%, respectively). Lesser use of digital radiography in dentistry may be due to many factors such as costly equipment, patient discomfort due to rigid sensors, and lesser active area of some sensors, lack of knowledge and difficulty in mastering digital image acquisition and processing.

One of the striking features of the present study was the reduced number of participants wearing lead apron while operating an x-ray unit, considering the beneficial effect of lead apron.

In present study, the percentage of dentists that always wore lead apron was 40.7% and 20% radiographers and 20 % of dental students which is a good increase compared to the study carried out by R. Jacobs, *et al.* in Belgian (2004) [7] where only 12% of the dentists wore lead apron while operating an x-ray unit though not a significant but the number of participants who were not wearing lead aprons would be owing to the general tendency that the radiation exposure due to dental X-ray machine is very less so less number of dentists are using lead apron and thyroid collar while exposure.

There have been some evidences that radiation exposure to the thyroid during pregnancy is associated with low birth weight. Protective thyroid collars substantially reduce radiation exposure to the thyroid during dental radiographic procedures.

The present study showed that only 20.7%of dentists, 42% of students and 50.5% of radiographers had reported that they will take radiographs for pregnant women and it was observed that 60% of students supported the fact that dental radiographs are absolutely contraindicated for the pregnant patients. This result varied from the study carried out by MPV Prabhat [13] and his associates, where only 6.4% of interns supported this fact. Around 80 % of participants reported that they will drape lead apron/thyroid collar over patients, indicating that a relatively high percentage of dentists, radiographers were aware of the potential of exposure or the possibility of minimizing this with the use of a

thyroid collar/lead apron in case of pregnant women.

Since every reasonable precaution should be taken to minimize radiation exposure, protective thyroid collars and aprons should be used whenever possible. This is recommended for all patients, especially for children, women of childbearing age, and pregnant women [5].

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 radiation protection but 75% of the dental practitioners, 83% of students and 90% of radiographers reported not using film holders. Most of the time, 54% dental professionals, 82.5% students and 60% radiographers asked their patients to hold the films inside the mouth with their fingers for almost every exposure. A surprising finding was that 30% (12) of the dentists and radiographers held the film themselves while the radiograph was being taken of the patient in accordance to study carried by Swarna Yerbairapura, *et al* [5]. where 13% of dentists held the film themselves while the radiograph was being taken of the patient because the clinicians and radiographers might risk exposure of radiations 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 to less concerned regarding the radiation.

The best way to ensure that personnel are following recommended safety protection measures is with the use of personal monitoring devices [5]. Several types of dosimeters including the thermo luminescence dosimeter, photoluminescence glass dosimeter, or optical stimulated luminescence dosimeter could be used to measure the exposure [5]. The results of the present study about (25%) students (40), radiographers and dental professionals use personal monitoring devices concur with the results of studies carried out by Kaviani, *et al* [11].

Majority of the clinics did not have a protective barrier due to unavailability of lead partitions in their clinical setup (70.3%). Only 30.8% of the dentists had followed the distance – direction law and in case of students (90%) and radiographers (42.5%) due to availability of lead partitions in their institutions they stand behind the lead partitions which indicates that dental Professional need to update knowledge regarding radiation protection. Most of the par-

ticipants (95%) shows a 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.

## Conclusion

The results of the study revealed the knowledge and awareness regarding radiation safety and protection were less among dentist, radiographers and dental students. Within the participants, the radiographers and dental students had better knowledge compared to dental practitioners in this study population. The present study highlights the need for training and recertification programs for improving the awareness and knowledge on effective radiation protection. It is recommended that the curriculum of dental school should be expanded further to improve the knowledge of radiation protection so that students on graduation will be well grounded with principles governing the radiation safety, justification and correct practice of ALARA. In order to persuade dental practitioners and radiographers to use low-dose practices, there is a need to expand knowledge and awareness by means of training and continuing dental education programs.

## Key Messages

Its alarming to keep an eye on radiation safety practices as number of participants are least concerned regarding the radiation received via dental radiography, hence there arises a need to update their knowledge and follow the radiation safety protocol.

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## Conflict of Interest

There are no financial or other relations that could lead to a conflict of Interest.

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