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## Assessment of knowledge, awareness and attitudes on dental radiation hazards and radiation protection among dentists in Pune

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### Abstract

**Background:** Radiological examination is an essential component of clinical dental practice, with significant advantages for both clinicians and patients. Because dentists are the ones who order the tests, they should be well-versed in radiation. They must determine if the benefits of radiographic information outweighs the risks of the patient's health. Dentists should be prepared to inform their patients about the dangers of X-rays. The purpose of this study was to assess knowledge, importance of radiation protection and radiation hazards among Interns and Dental professionals in Pune city.

**Materials and Methods:** A questionnaire study was conducted among the dental health professionals including the dental undergraduate interns of Pune city, Maharashtra, to assess the knowledge, attitude and awareness of dental radiation hazards and radiation protection. A structured, self-administered, close-ended questionnaire was designed to collect the data which consisted of two parts and comprised of 31 questions related to knowledge, attitudes and practices in dental radiation hazards and radiation protection. The first part consisted of demographic data and the second part consisted of questions based on knowledge, attitude and practice in dental radiation hazards and radiation protection. The reliability statistics were calculated and Cronbach alpha value was 0.618. Statistical analysis was done using descriptive statistics.

**Results:** In this study, there were a total of 159 participants of age 21 and above. 84.8% agreed that dental X-rays are harmful, while 15.2% participants answered No. 94.9% of dentists agreed that dental X-rays have stochastic and deterministic effects over a period of time and only 5.1% of the participants disagreed.

**Conclusion:** The study concluded that the knowledge and awareness regarding radiation hazards and radiation protection among dental health professionals was fair and adequate. Although a continual teaching and education at regular intervals is required to ensure that dentists are taking proper precautions for maximum safety.

**Keywords:** Dental x-rays, dental x-ray radiation, radiation protection, radiation hazards

### Introduction

It is well known that ionizing radiation has biological damaging effects, either affecting the cells directly or indirectly via the production of free radicals<sup>[1]</sup>. It is generally believed that the risk of radiation associated with dental radiography is not significantly greater than other everyday risks in life, especially intra-oral radiography<sup>[2]</sup>. However what is not known for certain, the degree of effect following the diagnostic level of x-ray radiations<sup>[3]</sup>. Biological hazards are classified based on occurrence probability into: Non-stochastic and Stochastic effects<sup>[4]</sup>. Non-stochastic or deterministic, in which there is determined dose above which damaging insults starts to appear<sup>[5]</sup>. Stochastic effects, meaning that there is no deterministic dose that could lead to biological damage. High dose ionizing radiation (x-ray) has both deterministic and stochastic effect<sup>[6]</sup>. The stochastic effects lay the patient and the operating personnel at a high risk zone as it does not have dose thresholds<sup>[7]</sup>. Radiological examination is an integral part of clinical dental practice, offering incalculable benefits to the clinicians and patients. Its roles range from diagnosis, treatment planning, treatment guidance, prediction of prognosis to monitoring of treatment outcome<sup>[8]</sup>. Although the diagnostic information provided by radiographs may be of definite benefits to the patients, the radiographic

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examination carries the potential for harm from ionizing radiation inducing carcinogenesis<sup>[9]</sup>. The amount of radiation exposure from dental radiographs depends on many variables starting from film speed, going through exposure factors, selected technique, collimation and protecting barriers used<sup>[10]</sup>. Dentists should have adequate knowledge about radiation, as they prescribe the examination. They decide that the value of information provided by radiographs outweighs the possible consequences for the patient's and the clinician's health<sup>[11]</sup>. The aim of this study is to assess knowledge, attitude and awareness of biological hazards of dental X-ray and appropriate radiographic protection among dentists in Pune, Maharashtra.

### Materials and Methods

A questionnaire study was conducted among the dental health professionals including the dental undergraduate interns of Pune city, Maharashtra, to assess the knowledge, attitude and awareness of dental radiation hazards and radiation protection. The questionnaire was distributed among dental interns, dental postgraduate students, private clinic dental practitioners, and private and government hospital dental practitioners. Non-practicing dentists, dental students and dental auxiliaries are excluded from the study. The input parameter for sample size calculation used as follows: 80% power of the study, alpha error 0.05, effect size 0.2, and degree of freedom as 5. The calculated sample size was 150 using G\*Power software version 3.1.9.4 (Heinrich Heine University, Düsseldorf). The final considered sample size for the study was around 159. The convenient sampling technique was used in the study. A structured, self-administered, close-ended questionnaire was designed to collect the data which consisted of two parts and comprised of 31 questions related to knowledge, attitudes and practices in dental radiation hazards and radiation protection. The first part consisted of demographic data such as age, qualification and hospital/clinic location and the second part consisted of questions based on knowledge, attitude and practice in dental radiation hazards and radiation protection. The questionnaire was online based and was prepared using Google forms (Google LLC, Mountain View, California, United States) and the link was distributed to the selected participants via e-mail, WhatsApp and other social media platforms (Instagram, Telegram, etc.). A brief introduction about the study was given and informed consent was also taken from all the participants. Data collected were entered in a spreadsheet (Microsoft Excel, 2016). Statistical analysis was done using descriptive statistics (number and percentage). SPSS (Statistical Package for the Social Science) 23.0 version software (IBM Chicago, Illinois, United States). The p-value was set at 0.05 or 5%.

### Results

In table 1, there were a total of 159 participants out of which 131 were of age group 21-30 years and 20 were of age group 31-40 years while the rest were from 40 years and above. Majority of the participants were BDS (63.5%), Interns were 23.3%, MDS were 12.6%, PhD were 0.6%. 64.8% participants were private clinic practitioners, 30.8% were students(postgraduate), 3.8% were private hospital practitioners and 0.6% were professors. In table 2, 84.8% agreed that dental X-rays are harmful and has stochastic effects, while 15.2% participants disagreed. 98.7% were aware of the radiation hazard symbol and 1.3% were unaware. 68.6% participants were aware of ALARA principle and the

rest did not know. About 77.4% participants were aware on how to wear personal radiation monitoring badges (TLD badge). In table 3, attitude of dental professionals regarding radiation protection and hazards was seen. 94.9% participants agreed that X-rays have stochastic/deterministic effects over a period of time. 81.1% participants agreed that X-rays can be reflected from the walls of the room, and the rest disagreed. On asking about whether X-rays are contraindicated in pregnant women, 44.1% participants agreed and majority were neutral or disagreed. 85.5% participants agreed that high speed films reduce radiation exposure and the rest disagreed. In table 4, practice related questions were asked to the dental professionals about radiation protection. Majority(91.2%) dentists used Digital radiography equipment in their daily practice thus, reducing the overall exposure. 76.7% of the dentists adhere to/will adhere to radiation protection protocol in their present clinical practice/future practice, the remaining 23.3% reasoned space availability, financial constraints or personal interest (may) prevail above protocol adherence.

### Discussion

Radiological examination is an integral part of clinical dental practice, offering incalculable benefits to the clinicians and patients. Its roles range from diagnosis, treatment planning, treatment guidance, prediction of prognosis to monitoring of treatment outcome.<sup>8</sup> Dentists should be well-versed in radiation because they are the ones who order the tests. They must assess if the benefit of the information offered by radiography outweighs the risks to the patient's health. Dentists should be prepared to warn patients about the potential risks associated with X-rays. The above objective can be achieved when the operating personnel empowers thorough knowledge and apply it in clinical situations. Keeping this in mind, in the present study, undergraduate Interns, General practicing dentists and specialist dentists were selected as participants. Several years ago many studies were directed for the measurement of radiation exposure and had shown the increased occurrence of cancer, abortion, fetus mutagenic changes, cataracts and shortening of life span. Although the previous statement being non-definite and non-applicable for diagnostic dental radiography, it is still acceptable to apply stochastic biological hazards effect<sup>[12]</sup>. Stochastic effects are those effects which follow the probability of occurrence of biological hazard effects, dose independent compared to deterministic effects (i.e. the patient may either shows biological damaging effect or not affected at all, with a minimal radiation exposure). Therefore, the radiation protection protocol should focus on prevention of the deterministic effects occurrence and to reduce the probability of stochastic effects, that is why dentists should be restricted to the "As Low As Reasonably Achievable" ALARA principle concept<sup>[12, 13]</sup>. Upon literature review, there was a lack of studies evaluating the knowledge of radiation protection and radiation hazards in the state of Maharashtra, especially in Pune city. The goal of this study was to assess dental radiation knowledge among dental health professionals in Pune city, Maharashtra, who prescribe and perform dental radiographs. A disregard for radiation risk may result in an excessive number of peri-apical radiographs being prescribed or repeated needlessly and unnecessarily. The good percentages of respondents, on the other hand, overestimate the risk of radiological evaluation of pregnant patients. One of the likely negative outcomes of this is that radiological diagnostics for pregnant women will be discontinued, even if the benefits outweigh the danger. Another less common but

conceivable result is dentists refusing to complete prescribed examinations for pregnant patients. To achieve these objectives, a full understanding and knowledge of the biological hazards of X-rays is required in order to implement effective radiation protection methods. Evaluation of the results of the current study showed that all the participants were aware of the fact that X-rays used in diagnostic dental radiology are harmful and certain levels of precautions should be taken while in use. Previous studies such as in Arnout, *et al* [14]. the study sample included only undergraduate dental students and did not include dentists and dental staff who were performing such procedures. The results of their study showed that among undergraduate dental students, 87.5% of them considered X-rays to be harmful. In our study, out of 159 dental professionals, 84.8% considered X-rays to be harmful. Also, according to Arnout, *et al* [14]. There was a question whether X-ray can be reflected from the walls of the room, 69.7% of undergraduate students answered yes [14]. While in this study, 81.1% of dentists agreed. In a study by Aravind, *et al* [15]. dentists were asked about ALARA principle and 84.3% answered that they know it. While in present study, only 68.6% dentists were aware of the ALARA principle. Furthermore, in the study by Arnout, *et al* [14]. 33.3% of the undergraduate dental students answered that dental radiographs are absolutely contraindicated in pregnant women, while in this study 44.1% dentists agreed that radiographs are absolutely contraindicated in pregnant women<sup>14</sup>. In a study by Dölekoğlu, *et al* [16]. 67% of the dentists said that they use digital radiography, while in this study 68.6% of dentists preferred using digital radiography. In a study by Arnout, *et al* [14]. They were asked about the importance of collimators and filters used in the dental X-ray

machine and only 30.3% of the undergraduate were aware, while in this study 88.1% have awareness of the usefulness of collimators and filters in dental radiography. In a study by Arnout, *et al* [14]. Only 70% of the undergraduate were unaware of the probability of occurrence of radiation biological damage, but in the current study, 94.9% of dentists agreed that dental X-rays have stochastic and deterministic effects over a period of time. In a study conducted by Eman, *et al* [17]. It showed that 66.7% of the clinical group answered yes that X-ray is harmful, and 33.3% who answered no about whether X-ray beams are reflecting from room walls. In this study, it has been shown that 87.5% of the dentists answered yes that X-ray is harmful, and 81.1% agreed about X-ray beams reflecting from walls of the room. Also, in their study, it has been shown that 68.0% of the participants claimed that they will adhere to radiation protection protocol in their future clinical practice. While in this study, 76.7% of the dentists adhere to/will adhere to radiation protection protocol in their present clinical practice/future practice, the remaining 23.3% reasoned space availability, finance constraints or personal interest (may) prevail above protocol adherence. We infer that radiation awareness among dental professionals in Pune city is fair based on the findings.

#### Limitations of this study

- Small sample size of the study.
- Majority of the participants were general practicing dentists.
- Majority worked in private clinics.
- The distribution was not equal between general dentists and specialists.

**Table 1:** Demographic details of study participants. (N=159)

Sr. No.	Demographic details	Response	N	%	Total N (%)
1.	Age	21-30 years	131	82.4%	159
		31-40 years	20	12.6%	
		41 and above	8	5.0%	
2.	Qualification	Interns	37	23.3%	159
		B.D.S	101	63.5%	
		M.D.S	20	12.6%	
		PhD	1	0.6%	
3.	Designation	Student	49	30.8%	159
		professor	1	0.6%	
		Private clinic practitioner	103	64.8%	
		Private hospital practitioner	6	3.8%	
		Govt. hospital practitioner	0	0	
4.	Clinic/Hospital Location	Urban	148	93.1%	159
		Rural	11	6.9%	

**Table 2:** Knowledge based Questions' responses of study participants (N=159)

Sr. No.	Questions	Responses	N	%	Total N (%)
1.	Do you think Dental X-rays are harmful?	Yes	134	84.8%	159
		No	24	15.2%	
2.	Are you aware of the X-ray dosage recommendation?	0.01-0.171 mSv	26	16.4%	159
		0.03-1.073 mSv	37	23.3%	
		0.055-0.171 mSv	59	37.1%	
		Don't Know	37	23.3%	
3.	Are you aware of the radiation hazard symbol?	Yes	157	98.7%	159
		No	2	1.3%	
4.	Which type of collimator is used in Dental X-rays?	Rectangular	17	10.7%	159
		Round/circle	41	25.8%	
		Triangular	4	2.5%	
		Both a and b	97	61%	
5.	Which filters are used in Dental X-rays?	Aluminium/copper(Al/Cu)	122	17.6%	159
		Silver(Ag)	4	2.5%	
		Glass/Insulating oil	5	3.1%	
		All of the above	28	76.7%	
6.	What do you think is the use of collimators and filters in Dental Radiography?	Reduce the amount of time required for exposure.	4	2.5%	159
		Attenuate (reduce) a portion of primary beam and low-energy x-ray photons.	5	3.1%	
		Limits the scattering of X-rays.	10	6.3%	
		All of the above.	140	88.1%	
7.	What is the ALARA principle for Radiation Exposure?	As low as radiation as possible	22	13.8%	159
		As low rates as possible	5	3.1%	
		As low as reasonably achievable	109	68.6%	
		Don't know	23	14.5%	
8.	Are you aware of basic radiation guidelines for dental x-rays?	Radiation should be used in a controlled area with proper protective equipment.	5	3.1%	159
		Follow ALARA principle for every patient.	4	2.5%	
		Proper disposal of radioactive waste.	2	1.3%	
		All of the above.	148	93.1%	
9.	Are you aware of different qualities of x-ray films available and their costs?	Yes	137	86.2%	159
		No	22	13.8%	
10.	What different speed films are available for conventional radiography?	A,B and C films	24	15.1%	159
		X, Y and Z films	4	2.5%	
		D,E and F films	122	76.7%	
		None of the above.	9	5.7%	
11.	What is the exposure required for different speed films?	1.3mGray for D and 1.7mGray for E and F films	13	8.2%	159
		1.1 mGray D and 1.5mGray for E and F films.	26	16.4%	
		1.7 mGray D and 1.3mGray for E and F films.	71	44.7%	
		Don't know	49	30.8%	
12.	The ideal distance an operator should stand while dental radiographic exposure is?	4 feet and 90-135 degrees	14	8.8%	159
		4 feet and 60-90 degrees	8	5%	
		6 feet and 90-135 degrees	122	76.7%	
		6 feet and 60-90 degrees	15	9.4%	
13.	Are you aware of the disposal methods of developer and fixer solutions?	Pour it down the drain.	5	3.1%	159
		Dispose it off-site as non-hazardous waste.	3	1.9%	
		Proper labelling of waste and to be collected by local disposal or waste management team.	131	82.4%	
		All of the above.	20	12.6%	
14.	Are you aware of receiving TLD badges and sending TLD for interpretation?	Contact a government approved TLD lab.	138	86.8%	159
		Contact your local dental technician.	2	1.3%	

		Buy TLD badges from local store and interpret it yourself.	1	0.6%	
		Don't know	18	11.3%	
15.	Personal monitoring badges should be worn by the operator ____	Above the lead apron.	123	77.4%	159
		Under the lead apron.	18	11.3%	
		Doesn't matter, can be worn either way.	3	1.9%	
		Don't know	15	9.4%	

**Table 3:** Attitude Related Questions' responses of study participants (N=159)

Sr. No.	Questions	Responses	N	%	Total N(%)
1.	X-rays can have stochastic (cancer and genetic) effects over a period of time.	Strongly Agree	112	70.4%	159
		Agree	39	24.5%	
		Neutral	6	3.8%	
		Disagree	1	0.6%	
		Strongly Disagree	1	0.6%	
2.	X-rays can be reflected from the walls of the room.	Strongly Agree	56	35.2%	159
		Agree	73	45.9%	
		Neutral	24	15.1%	
		Disagree	5	3.1%	
		Strongly Disagree	1	0.6%	
3.	What do you think about the statement "digital radiography requires less exposure than conventional"	Strongly Agree	44	27.7%	159
		Agree	78	49.1%	
		Neutral	18	11.3%	
		Disagree	11	6.9%	
		Strongly Disagree	8	5%	
4.	Dental Radiographs are absolutely contraindicated in pregnant woman.	Strongly Agree	26	16.4%	159
		Agree	44	27.7%	
		Neutral	44	27.7%	
		Disagree	42	26.4%	
		Strongly Disagree	3	1.9%	
5.	High speed films reduces exposure.	Strongly Agree	55	34.6%	159
		Agree	81	50.9%	
		Neutral	23	14.5%	
		Disagree	0	0%	
		Strongly Disagree	0	0%	
6.	X-ray film holder usage is important in your daily practice.	Strongly Agree	19	11.9%	159
		Agree	82	51.6%	
		Neutral	42	26.4%	
		Disagree	14	8.8%	
		Strongly Disagree	2	1.3%	
7.	X-ray film should be held in your hand during exposure without film holder.	Strongly Agree	6	3.8%	159
		Agree	32	20.1%	
		Neutral	66	41.5%	
		Disagree	36	22.6%	
		Strongly Disagree	19	11.9%	
8.	The patient can hold the film in their hand during exposure.	Strongly Agree	8	5%	159
		Agree	43	27%	
		Neutral	60	37.7%	
		Disagree	40	25.2%	
		Strongly Disagree	8	5%	

**Table 4:** Practice Related Questions' responses of study participants (N=159)

Sr. No.	Questions	Responses	N	%	Total N (%)
1.	What kind of radiography equipment do you prefer in daily clinical use?	Conventional	14	8.8%	159
		Digital	109	68.6%	
		Both	36	22.6%	
2.	If using conventional, do you take proper precautions for disposal of developer and fixer solutions?	Always	119	74.8%	159
		Often	27	17%	
		Rarely	9	5.7%	
		Never	4	2.5%	
3.	How often do you repeat x-rays in a single patient?	Always	5	3.1%	159
		Often	101	63.5%	
		Rarely	50	31.4%	
		Never	3	1.9%	
4.	Will you/do you adhere to radiation protection protocol at the time of your current/future private clinical practice?	Always	122	76.7%	159
		Often	26	16.4%	
		Rarely	7	4.4%	
		Never	4	2.5%	
5.	If rarely/never then why?	Not enough space availability	7	4.4%	159
		Financial reasons	7	4.4%	
		Private clinical setup has less radiation exposure hence it does not require stringent protection measures	10	6.3%	
		N/A	135	84.9%	
6.	Do you prefer using lead apron or other x-ray protection equipment daily?	Always	90	56.6%	159
		Often	32	20.1%	
		Rarely	33	20.8%	
		Never	4	2.5%	
7.	If rarely/never, why?	Non availability of Lead aprons	14	8.8%	159
		Heavy weight of the apron	23	14.5%	
		Time consuming/unnecessary	16	10.1%	
		N/A	106	66.6%	
8.	Do you use/operate other dental x-rays other than IOPA/bitewing etc. in your daily practice (panoramic/CBCT)?	Always	10	6.3%	159
		Often	109	68.6%	
		Rarely	21	13.2%	
		Never	19	11.9%	

## Conclusion

From the results obtained through this study, the knowledge regarding radiation protection and radiation hazards among undergraduate Interns and dental professionals, in Pune city, is fair. The radiation protection principle entails taking particular safeguards to reduce dental professionals' and patients' exposure to radiation while also providing advantages to the patients. The knowledge and attitudes among the younger age group dentists was found to be higher compared to the older age groups. This could be due to the fact that the knowledge in younger dentists was fresh and recent as compared to older dentist. A radiation protection seminar/lecture at continual intervals is required at institutional level or district level, to ensure that dentists are taking proper precautions for maximum safety in their daily practice.

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