

# Factors determining Radiation Protection Practices among Indian General Dental Practitioners: An Explorative Study

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## ABSTRACT

**Introduction:** Radiation exposure encountered in dentistry is minimal; however, their harmful effects cannot be ruled out. Though there are several guidelines established to minimize exposure to X-rays in dentistry, earlier studies have reported that practitioners are not entirely compliant with the same. There is, therefore, a definite need to identify factors that influence compliance with radiation protection practices among general dental practitioners (GDPs).

**Objective:** The objective is to assess various factors influencing radiation protection practices among Indian GDPs.

**Materials and methods:** A cross-sectional study design using a pretested, self-administered, structured questionnaire comprising of 37 items was employed in the present study. Information pertaining to demographics and radiation protection practices among GDPs was collected.

**Results:** A total of 66.7 and 49.4% did not follow position and distance rule respectively; overall, 88.5 and 94.3% did not use lead apron and thyroid collar respectively, for their patients. It was observed that 60.9% did not adjust exposure parameters according to tooth position; a total of 94.2% did not use personal dosimeters, while 63.2% disposed radiographic waste in common drain. Correlation analysis revealed significant association of awareness about governing bodies with educational course, distance rule with years of practice, personal dosimeter usage with gender, and other patients' exposure to radiation with type of practice of the participants ( $p < 0.05$ ).

**Conclusion:** The present study revealed poor radiation protection practices among GDPs. Low compliance with personnel- and patient-related protection measures was observed. A majority of the respondents were not familiar with radiation protection guidelines. Correlation analysis revealed important demographics that were influencing radiation protection practices among the respondents. The present study highlights crucial policy implications to ensure greater compliance with appropriate radiation protection guidelines among GDPs in India.

**Keywords:** Demographics, General dental practitioners, Guidelines, Radiation protection.

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## INTRODUCTION

Discovery of X-rays revolutionized the way the human body was looked upon. However, within no time, the harmful effects of X-rays were witnessed, and alarm was raised against the ill effects of ionizing radiation.<sup>1-3</sup> Soon, various protective measures were initiated and continue to be implemented even today. The contemporary notion in this regard is to make radiographs when the risks of exposure outweigh the benefits and the exposure to ionizing radiation must be as minimal as practically possible.<sup>3,4</sup>

In dentistry, radiographs are used extensively in the diagnosis and management of various oral health problems. Although the radiation exposure encountered in dentistry is minimal, their harmful effects cannot be ruled out.<sup>1-4</sup> Over the years, many guidelines have been established to minimize exposure to ionizing radiation in dentistry.<sup>4-7</sup> Guidelines are available for protection of patients, operator, and the environment. Various aspects of radiation protection, such as radiographic equipment, exposure techniques, and processing and interpretation of radiographs need to be considered for minimizing radiation exposure.<sup>4-7</sup>

Despite the availability of various guidelines, literature reveals lack of compliance among practicing dentists toward the dose-reduction techniques.<sup>8-13</sup> As a result, it is essential to identify the factors that influence compliance with radiation protection measures among dental practitioners, which might pave the way for better acceptance of radiation protection techniques among its end users.

There is definite dearth of studies that comprehensively investigate factors related to radiation protection practices among general dental practitioners (GDPs) in the Indian context. A comprehensive view of various factors might shed valuable insight into the radiation protection practices among GDPs. Hence, the present study was undertaken to assess factors influencing the extent of adherence among Indian GDPs with the radiation protection standards.

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## MATERIALS AND METHODS

The present study was conducted among GDPs in Mangaluru city, Karnataka. Permission was obtained from the Institution Ethics Committee, Manipal College of Dental Sciences, Mangaluru, prior to conduction of the study. The purpose of the study was explained to the GDPs of Mangaluru city, Karnataka, India, and informed consent was obtained. A cross-sectional questionnaire design was employed in the present study. Dental practitioners who were not using radiographic equipment were not included in the study.

A structured, pretested, self-administered questionnaire comprising 37 items focusing on the radiation protection practices was employed in the present study. Information pertaining to demographic data, such as age, gender, educational qualification, type and years of practice, and attachment to any academic institution was also collected.

Data were analyzed using Statistical Package for Social Sciences (SPSS), version 16.0 (Inc, Chicago, IL). Chi-square test was used for comparison of categorical data.

## RESULTS

A response rate of 72.5% was observed in the present study. Results indicate that the majority of the study subjects were males,  $\leq 40$  years (78.2%) of age, had completed postgraduation (62.1%) in dentistry, were involved

in private practice as well as educational setup (59.8%), and were involved in dental practice for  $\leq 10$  years (71.3%) (Table 1).

Table 2 depicts awareness-based radiation protection behaviors among dental practitioners. Majority of subjects reported that during pregnancy, in case of emergencies, radiographs can be taken using lead apron ( $n = 74$ , 85%); 82 (94.3%) noted that radiographs need not be taken for all the patients visiting dental clinic; 52 (59.8%) were aware of the governing bodies of radiation protection. However, only 7 (8%) subjects were aware that even a single radiograph can cause harm to the patient, and 46 (52.9%) were not aware of the National Council

**Table 1:** Demographic distribution of the study subjects

Demographic variable		Number of study subjects
Age	$\leq 40$ years	68
	$\geq 41$ years	19
Sex	Male	45
	Female	42
Education course	BDS	33
	MDS	54
Type of practice	Private practice	35
	Private practice with educational institution	52
Years of practice	$\leq 10$ years	62
	$\geq 11$ years	25

BDS: Bachelor of Dental Surgery; MDS: Master of Dental Surgery

**Table 2:** Knowledge-based radiation protection practices among the study subjects

Radiation practices	n (%)	Age		Sex		Education course		Type of practice		Years of practice		
		$\leq 40$ years	$\geq 41$ years	Male	Female	BDS	MDS	Private practice	Private with institution	$\leq 10$ years	$\geq 11$ years	
Radiographs during pregnancy	Can be taken without lead apron/are contraindicated	13 (15)	11	2	7	6	3	10	5	8	9	4
	In case of emergencies can be taken with lead apron	74 (85)	57	17	38	36	30	44	30	44	53	21
Radiographs should be taken to all the patients visiting dental clinic	Yes	5 (5.7)	4	1	1	4	1	4	0	5	2	3
	No	82 (94.3)	64	18	44	38	32	50	35	47	60	22
Do you think single radiograph can cause harm to the patient?	Yes	7 (8)	61	19	41	39	29	51	31	49	56	24
	No	80 (92)	7	0	4	3	4	3	4	3	6	1
Are you aware of governing bodies of radiation protection?	Yes	52 (59.8)	25	10	17	18	9*	26*	12	23	26	9
	No	35 (40.2)	43	9	28	24	24*	28*	23	29	36	16
Are you aware of NCRP, ICRP guidelines for radiation protection?	Yes	41 (47.1)	33	13	26	20	15	31	16	30	33	13
	No	46 (52.9)	35	6	19	22	18	23	19	22	29	12

\*Significant at 5% level of significance; BDS: Bachelor of Dental Surgery; MDS: Master of Dental Surgery

**Table 3:** Radiographic technique-related practices among dental practitioners

<i>Radiation practices</i>		<i>Number (%)</i>
What technique do you follow to obtain radiographs?	Bisecting angle technique	43 (49.4)
	Paralleling technique	26 (29.9)
	Combination	18 (20.7)
How often do you use high-speed films?	Always	46 (52.9)
	Sometimes	29 (33.3)
	Never	12 (13.8)
Do you adjust the exposure parameters according to the location of the tooth to be radiographed?	Always	34 (39.1)
	Sometimes	39 (44.8)
	Never	14 (16.1)
Stabilization of film in patient's mouth	Use film holding device always	43 (49.4)
	Operator stabilizes the film always	1 (1.2)
	Patient stabilizes the film with finger always	14 (16.1)
	Combination	29 (33.3)
How often do you use film viewing box?	Always	36 (41.4)
	Sometimes	35 (40.2)
	Never	16 (18.4)
Do you take full mouth radiographs for all the patients visiting the clinic?	Yes	1 (1.2)
	No	86 (98.8)
Do you take panoramic radiographs for all the patients visiting the clinic?	Yes	4 (4.6)
	No	83 (95.4)

on Radiation Protection and Measurements (NCRP) and International Commission on Radiological Protection (ICRP) guidelines.

Study results with respect to X-ray machine revealed that 82 (94.3%), 21 (24.1%), and 7 (8%) practitioners had intraoral conventional, digital, and panoramic radiographic equipments respectively, in their clinics. A total of 41 (47.2%) respondents had license for their X-ray machines. Majority (n = 49, 56.3%) of the participants used ≤10 years old X-ray machines, whereas 32 (36.78%) were unsure of the age of their X-ray machine and 6 (6.9%) were using ≥10 years old equipment. Majority (n = 60, 69%) of the study subjects also checked their X-ray equipment periodically. Majority of the radiographs were taken by the dental practitioners (n = 61, 70.2%), and on an average they were taking ≤10 radiographs per week (n = 53, 60.9%). When enquired about exposure parameters of their X-ray machine, only 5 (5.8%) were aware of the details, whereas 64 (73.6%) were unsure and remaining 18 (20.7%) either knew milliamperage or kilovoltage peak alone. Most of the participants used long cone X-ray machine (n = 47, 54%) with round collimator (n = 46, 52.9%).

Radiographic technique-related practices revealed that most of them did not take full mouth (n = 86, 98.8%) and panoramic radiographs (n = 83, 95.4%) for their patients prior to dental treatment. A total 43 (49.4%) respondents employed bisecting angle technique; 46 (52.9%) always used high-speed films; 43 (49.4%) always

used film holding devices; and 36 (41.4%) used film viewing box. However, majority (n = 53, 60.9%) of the practitioners only sometimes or never adjusted the exposure parameters according to the location of the tooth to be radiographed (Table 3). As shown in Table 4, most of the practitioners used manual processing (n = 78, 89.7%) and changed processing solutions ≤2 weeks (n = 54, 62.1%). However, majority of them (n = 55, 63.2%) disposed radiographic waste in common drain.

Personnel protection measures adopted by the dental practitioners are presented in Table 5. Fifty-eight (66.7%) subjects neither followed position rule nor used lead barrier; 43 (49.4%) respondents did not follow distance rule while exposing radiographs; only 22 (25.3%) subjects always used lead barrier while exposing radiographs, whereas personal dosimeters were donned only by 5 (5.8%) subjects.

**Table 4:** Radiographic processing-related practices among dental practitioners

<i>Radiation practices</i>		<i>Number (%)</i>
What type of radiographic processing do you use?	Automatic	5 (5.8)
	Manual	78 (89.7)
	Combination	4 (4.6)
How often do you change radiographic solutions?	≤2 weeks	54 (62.1)
	Variable	33 (37.9)
How do you dispose radiographic waste in your clinic?	Recycle	32 (36.8)
	Dispose in common drain	55 (63.2)

**Table 5:** Personnel protection measures followed by the dental practitioners

Radiation practices	n (%)	Age		Sex		Education course		Type of practice		Years of practice		
		≤40 years	≥41 years	Male	Female	BDS	MDS	Private practice	Private with institution	≤10 years	≥11 years	
		What is your most frequent position while shooting radiographic films?	90–130° to the primary beam	7 (8.1)	13	2	5	10	8	7	9	6
	Behind lead barrier	22 (25.3)										
	Variable position	58 (66.7)	55	17	40	32	25	47	26	46	53	19
How far from the source of X-rays do you usually stand while shooting radiographic films?	≥6 feet	44 (50.6)	34	10	21	23	18	26	19	25	26*	18*
	Variable position	43 (49.4)	34	9	24	19	15	28	16	27	36*	7*
Do you use a lead barrier while exposing radiographs?	Always	22 (25.3)	16	6	13	9	9	13	11	11	14	8
	Sometimes	20 (23)	17	3	7	13	11	9	8	12	12	8
	Never	45 (51.7)	35	10	25	20	13	32	16	29	36	9
Do you use personal dosimeter device?	Always	5 (5.8)	4	1	3*	2*	2	3	2	3	4	1
	Sometimes	11 (12.6)	9	2	2*	9*	7	4	6	5	6	5
	Never	71 (81.6)	55	16	40*	31*	24	47	27	44	52	19

\*Significant at 5% level of significance; BDS: Bachelor of Dental Surgery; MDS: Master of Dental Surgery

**Table 6:** Patient protection measures followed by the dental practitioners

Radiation practices	n (%)	Age		Sex		Education course		Type of practice		Years of practice		
		≤40 years	≥41 years	Male	Female	BDS	MDS	Private practice	Private with institution	≤10 years	≥11 years	
		How often do you make the patient wear lead apron?	Always	10 (11.5)	9	1	4	6	3	7	3	7
	Sometimes	43 (49.4)	32	11	22	21	18	25	20	23	30	13
	Never	34 (39.1)	27	7	19	15	12	22	12	22	25	9
How often do you make the patient wear thyroid collar?	Always	5 (5.7)	5	0	2	3	0	5	1	4	3	2
	Sometimes	32 (36.8)	26	6	14	18	15	17	16	16	35	7
	Never	50 (57.5)	37	13	29	21	18	32	18	32	24	16
Are other patients exposed to radiation?	Always	2 (2.3)	1	1	2	0	0	2	0*	2*	1	1
	Sometimes	21 (24.1)	18	3	11	10	6	15	4*	17*	18	3
	Never	64 (73.6)	49	15	32	32	27	37	31*	33*	43	21
Are the patient's attendants exposed to radiation?	Always	4 (4.6)	3	1	3	1	1	3	1	3	3	1
	Sometimes	28 (32.2)	21	7	17	11	10	18	11	17	23	5
	Never	55 (63.2)	44	11	25	30	22	33	23	32	36	19
Do you use radiation hazard symbol in your clinic?	Yes	13 (14.9)	11	2	6	7	6	7	6	7	11	2
	No	74 (85.1)	57	17	39	35	27	47	29	45	51	23
Are the walls, windows, and doors of your clinic radiation protected?	Yes	20 (23)	16	4	10	10	11	9	11	9	15	5
	No	67 (77)	52	15	35	32	22	45	24	43	47	20

\*Significant at 5% level of significance; BDS: Bachelor of Dental Surgery; MDS: Master of Dental Surgery

Patient protection measures exercised by the respondents are displayed in Table 6. Only 10 (11.5%) and 5 (5.7%) subjects always used lead apron and thyroid collar respectively, for their patients before X-ray exposure. Majority of them (n = 67, 77%) never used radiation-protected walls, windows, doors, and 74 (85.1%) never used radiation hazard symbol in their clinic. On the contrary, majority reported that other patients (n = 64, 73.6%) or their attendants (n = 55, 63.2%) were never exposed to X-rays.

Correlation analysis of knowledge-based practices and personnel- and patient protection-related practices with respect to demographics revealed significant association of awareness about governing bodies with educational course; distance rule followed by the respondents with years of practice of the study subjects; usage of personal dosimeter with gender of an individual and other patients' exposure to radiation with type of practice of the participants (Tables 2, 5, and 6).

## DISCUSSION

Despite the existence of numerous guidelines, literature is replete with reports indicating noncompliance of dental practitioners to the same worldwide.<sup>8-13</sup> Although fewer studies are conducted in India pertaining to radiation protection, in-depth exploratory studies are sparse. There is need to identify the lacunae in radiation protection practices, so that the newer policies can be bought in or the existing ones could be reinforced according to the changes required. The present study was undertaken to assess the radiation protection practices among dental practitioners and to evaluate the role of demographics on their radiation protection practices.

In order to control radiation-induced hazards, guidelines are formulated for every step of production of radiographs that may broadly comprise patient selection, X-ray equipment, radiographic techniques, personnel and patient protection measures, and maintenance of radiographic waste. Prescription of radiographs should be restricted to conditions wherein radiographs add significant information toward patient management.<sup>3,4</sup>

Majority of the present study subjects (94.3%) were of the opinion that routine radiographs should not be taken for all the patients, and most of them did not take routine full mouth (98.8%) and panoramic radiographs (95.4%) for their patients. These reports confirm the findings of Shahab et al<sup>12</sup> and Chaudhry et al.<sup>13</sup> Lee and Ludlow,<sup>14</sup> however, reported that 34.1% of their study subjects preferred prescription of routine radiographs for their patients. Majority of the present study subjects thought that during pregnancy, only in case of emergencies, radiograph can be taken with appropriate radiation protection measures. These findings are consistent with reports of Chaudhry et al;<sup>13</sup> however, they conflict the results of Shahab et al.<sup>12</sup> Although present study participants were aware of the existence of guidelines for radiation protection, majority of them were not aware of NCRP and ICRP guidelines and that single radiograph can cause harm.

X-ray equipment and its maintenance is of critical importance in radiation protection.<sup>3</sup> Digital imaging facilitates enhancement of image in a number of ways; however, it carries risk of multiple retakes. In the present study, conventional radiography was the most commonly used form of X-ray source, while 21% were using digital radiographic equipment. These results are consistent with the reports of Shahab et al<sup>12</sup> and Chaudhry et al;<sup>13</sup> however, the results are not in agreement with that of Lee and Ludlow,<sup>14</sup> who noted 77.2% of their study subjects were using digital radiography.

Quality assurance check periodically is of utmost importance in order to maintain optimum functioning of the X-ray machine without any leakage.<sup>15</sup> In contrast to

the findings of Shahab et al<sup>12</sup> and Chaudhry et al,<sup>13</sup> who pointed that 61 and 81% respectively, of their study subjects did not check their X-ray equipment regularly, 69% of the present study subjects conducted periodic quality check for the their X-ray equipment. Further, 56.3% of the participants used  $\leq 10$  years old X-ray machines. These practices are better than that reported in previous studies, which could be attributed to higher number of subjects with higher education in the present study.

Details pertaining to radiographic equipment and technique are crucial in radiation protection. On an average, dental practitioners were taking  $\leq 10$  radiographs per week. Similarly, Shahab et al<sup>12</sup> and Jacobs et al<sup>16</sup> reported that their study subjects were making 6 to 15 and 40 to 80 radiographs per week respectively. Majority (94.3%) were either unsure or had partial knowledge about exposure parameters of their X-ray machine, which is similar to the reports of Sheikh et al<sup>10</sup> and Salti and Whaites.<sup>17</sup> Long cone, rectangular collimator, paralleling technique, high-speed films, film holding devices, and film viewing box are preferred measures to achieve accurate images with minimal exposure to the patient.<sup>3</sup>

Study subjects of the present study demonstrated favorable practices pertaining to use of long cone X-ray machine (54%); high-speed films always (52.9%); and film holding devices always (49.4%). Similar findings were reported by Geist and Katz,<sup>18</sup> with 50.5% of long cone, 64.6% of E-speed films, and 43% of film holder usage in their study. Shahab et al<sup>12</sup> noted 62% usage of E-speed films; however, 15% use long cone and 12% use film holders in their study. On the contrary, majority of present study respondents used round collimator (52.9%) and employed bisecting angle technique (49.4%), which is consistent with the findings of Shahab et al,<sup>12</sup> Lee and Ludlow,<sup>14</sup> Sheikh et al<sup>10</sup> and Chaudhry et al.<sup>13</sup> Majority (60.9%) of the practitioners only sometimes or never adjusted the exposure parameters according to the location of the tooth to be radiographed, which is similar to the reports of Shahab et al<sup>12</sup> and Chaudhry et al<sup>13</sup> and contrary to Sheikh et al<sup>10</sup> and Jacobs et al.<sup>16</sup> Only 41.4% used film viewing box in the present study in contrast to 75% usage reported by Salti and Whaites.<sup>17</sup> Majority (63.2%) of the practitioners disposed of radiographic waste in common drain, which is similar to the reports of Chaudhry et al<sup>13</sup> and Praveen et al.<sup>15</sup>

Majority of the study subjects did not follow appropriate position or distance from X-ray source, which is consistent with the reports of Chaudhry et al.<sup>13</sup> Only a minority of them used personal dosimeters while exposing radiographs, which is similar to the results of Mehta et al.<sup>19</sup> Regular monitoring of X-ray exposure might raise an alarm about the potential damages and hence, might promote better radiation protection practices. Majority of

the study respondents claimed that other patients or their attendants were never exposed to X-rays. However, only few of them always used lead apron and thyroid collar for their patients, which is consistent with the results of Lee and Ludlow<sup>14</sup> and Chaudhry et al.<sup>13</sup> Majority of them never used radiation-protected walls, windows, doors, and radiation hazard symbol in their clinic. These findings point toward the existing lacuna that needs to be addressed immediately in order to promote better radiation protection practices pertaining to the X-ray machine and radiographic technique. Hence, there is an urgent need to bring in policy changes to ensure greater compliance among dental practitioners in abiding with the recommended guidelines.

Statistically significant association of knowledge-based practices and personnel and patient protection-related practices with respect to demographics revealed significant association of awareness about governing bodies with educational course; distance rule followed by the respondents with years of practice of the study subjects; usage of personal dosimeter with gender of an individual and other patients' exposure to radiation with type of practice of the participants. However, in a similar study conducted by Shahab et al<sup>12</sup> no significant difference was found between general and specialist dentists with respect to usage of patient protective wear, correct use of position and distance rule, and appropriate management of radiographic waste; and Chaudhry et al<sup>13</sup> found no significant difference based on gender with respect to periodic checkup of X-ray machines, position and distance rule, and proper disposal of radiographic waste.

The present study must be viewed under its limitations that might include questionnaire study-related biases, such as social desirability bias, acquiescence bias, and yea-saying bias. The findings from practitioners of one city in India might not be representative of the entire nation. The cross-sectional nature of the present study might not shed light on predictive behaviors. Therefore, further studies are needed to confirm the findings of the present study. The present study, thus, might provide valuable baseline information to further explore various aspects of radiation protection practices among GDPs in India.

## CONCLUSION

Radiation protection practices among GDPs in the present study were found to be deficient. A majority of them did not follow the personnel- and patient-related radiation protection measures. Results also indicate that most of the respondents were not employing paralleling technique, did not adjust exposure parameters according to the tooth, and were disposing radiographic wastes in common drain. A majority of the respondents were

not familiar with radiation protection guidelines, and a majority of them reported that a single radiograph cannot harm the patient.

Correlation analysis revealed that awareness about governing bodies was significantly associated with educational course; distance rule followed by the respondents was significantly associated with years of practice of the study subjects; usage of personal dosimeter with gender of an individual, and other patients' exposure to radiation with type of practice of the participants. The present study has critical policy implications for ensuring greater compliance with radiation protection guidelines among GDPs in India. There is also a definite need to conduct continuing professional development programs for GDPs to familiarize them with the recent advances in the field of radiation protection.

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