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Original Research

Evaluation of Radiation Protection Awareness amongst General Dental Practitioners of Western Rajasthan in India

Bhavana Agrawal[1], Tanvi Dosi[2], Alka Hazari[3], Charu Maheshwari[4], Rajan Rajput[2], Nidhi Yadav[2]

Contributors:

[1]Professor and Head, Department of Oral Medicine & Radiology, Jodhpur Dental College General Hospital, Jodhpur, Rajasthan, India; [2]Senior Lecturer, Department of Oral Medicine & Radiology, Jodhpur Dental College General Hospital, Jodhpur, Rajasthan, India; [3]Reader, Department of Oral Medicine & Radiology, Jodhpur Dental College General Hospital, Jodhpur, Rajasthan, India; [4]Post-graduate Student, Department of Oral Medicine & Radiology, Jodhpur Dental College General Hospital, Jodhpur, Rajasthan, India.

Correspondence:

Dr. Agrawal B. Department of Oral Medicine & Radiology, Jodhpur Dental College General Hospital, Jodhpur - 342 001, Rajasthan, India. Phone: +91-9602483826. E-mail: drbhavana_1@yahoo.com

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Abstract:

Background: Dental radiography is routinely used in clinical dentistry, but principles of radiation protection are not taken into consideration by many practicing dentists. Hence, this study is undertaken to evaluate dentists' attitude toward radiation hazards and awareness regarding radiation protection techniques in dental clinics amongst dental practitioners of Western Rajasthan.

Materials and Methods: In this cross-sectional study, awareness regarding radiation safety measures in dental clinics was assessed on 163 dental practitioners of Western Rajasthan during a Continuing Dental Education Programme (CDE).

Results: 48.46% dentist had poor, and 49.07% had moderate knowledge about radiation protection in dental radiology. Only 2.45% had thorough knowledge about radiation protection techniques.

Conclusion: It was alarming to know that dentist's knowledge and awareness regarding radiation protection techniques in dental clinics was not satisfactory. Therefore, more emphasis should be placed on radiation hazards and radiation protection techniques in undergraduate and post-graduate curriculum and CDE programmes. The dentists must update themselves regarding radiation protection techniques to improve their radiology practice in the welfare of both patients and themselves.

Key Words: Dental radiography, radiation hazards, radiation protection

Introduction

The radiographic examinations are more routinely used to diagnose dental pathologies than any other medical specialty. Therefore, as low as reasonably achievable (ALARA) principle become more important in dental radiological practice to reduce radiation exposure.[1] The aim of ALARA principles in dental radiology is aimed at justification, selection criteria, equipment, and quality assurance.[1,2]

However, the hazards caused by dental radiography are relatively small; some epidemiological studies report a higher prevalence of thyroid[3] and breast cancer[4] in female dentists and of melanomas in male dentists.[5] Although radiation doses in dental practice are relatively low, but the cumulative effect of repeated exposure should be kept in mind.

In India, diagnostic radiation facilities are governed by Atomic Energy Regulatory Board (AERB). The role of the AERB is to ensure that use of ionizing radiation and nuclear energy in India does not cause undue risk to the health of people and the environment.

It is mandatory to register all diagnostic radiation facilities in e-Licensing of Radiation Application (eLORA) system of AERB. From December 1st, 2013, it is compulsory for dental practitioners and dental institutions to register in eLORA and obtain a license to operate dental X-ray units, panoramic machines, and cone beam computed tomography. It is also necessary for manufactures of diagnostic X-ray machines to obtain a license for sale in India by AERB.

In view of current AERB norms in field of radiation protection we have undertaken this study amongst dental practitioners of Western Rajasthan in India to evaluate dentists' attitude toward radiation hazards and awareness regarding radiation protection techniques in dental clinics. To best of our knowledge, no such study regarding the assessment of awareness about radiation protection in dental radiography was done in India.

Materials and Methods

The cross-sectional study was conducted during a Continuing Dental Education Programme (CDE). Ethical clearance was taken from Committee of Jodhpur Dental College General Hospital and written informed consent was obtained from all the study subjects. A total of 220 dental practitioners from different areas of Western Rajasthan participated in CDE programme. The assessment of knowledge and awareness regarding radiation safety and their personal practice regarding the use of protection devices was performed by

designing a questionnaire which consisted of 15 questions. The questionnaire was composed in such a manner that these would allow assessment of the compliance of the dental offices to radiation protection. The total of 163 dentists completed the questionnaire and were included in the study. Incomplete questionnaires were excluded from the study. The first part contained information about demographic data such as name, age, sex, and work experience, while the second part was about attitude and knowledge of dental personnel about the type of equipment used radiation hazards and protection devices. Knowledge scores were classified as follows: 0-5 as poor knowledge, 5-10 as moderate knowledge, and 10-15 as excellent knowledge.

Statistical analysis

Data of the study were collected and entered into the computer in excel sheet. For calculating knowledge score, participants were classified into three age groups 25-34 years, 35-44 years, older than 45 years. Mean of knowledge scores among study groups analyzed by analysis of variance. The participants were also classified according to their gender to calculate knowledge score. Mean knowledge score between two gender groups analyzed by unpaired *t*-test. $P < 0.05$ was assumed as significant results.

Results

In the present study, out of 163 dentists participated, 74.84% (122) were males, and 25.15% (41) were females. 32 dentists were in age group of 25-34 years, 67 were in 35-44 years age group, and remaining 64 dentists were above 45 years of age.

48.46% dentist had poor and 49.07% had moderate knowledge about radiation protection in dental radiology. Only 2.45% had thorough knowledge about radiation protection techniques.

Among study participants, dentist older than 45 years age group had the highest mean knowledge score (5.7) and dentist with 25-35 years age group had the lowest knowledge score (5.53). However, there was no significant difference between mean of knowledge scores among three age groups ($P = 0.95$) (Table 1).

The female dentist had the higher mean knowledge score (5.68) compared with males of the study group (5.61). However, this difference was found to be statistically non-significant ($P = 0.87$) (Table 2).

Apart from the knowledge score, following were the important highlights of the study:

Type dental X-ray unit used

In our study, only 8.58% of dentists were having AERB certified X-ray equipment and 91.41% of dentists were using non-AERB certified machine, and 73.61% of them were not aware of AERB certification.

Table 1: Knowledge score of participants according to age group.

Age group (years)	Number of participants	Mean	Standard deviation	Median
25-34	32	5.53	2.81	6
35-44	67	5.59	2.96	6
>45	64	5.7	2.45	5.5

Table 2: Knowledge score of participants according to gender.

Gender	Number of participants	Mean	Standard deviation	Median
Male	41	5.68	2.90	6
Female	122	5.61	2.68	6

Digital radiographic system was used by 38.7% dentist, whereas 50.3% used analog receptors, and 11% dentists used both digital and an analog system.

Only 36.80% dentists were aware of quality assurance tests of X-ray equipment which are made compulsory by AERB. None of the study participants ever opted for quality assurance tests of their dental X-ray units.

Since position indicating device (PID) and collimator play an important role in preventing scattered radiation by limiting the size of primary X-ray beam. We enquired about the type of PID used by the clinicians. 74.2% dentists used cylindrical PID and 25.8% dentists are still using cone-shaped PID. This was found in older machines, and it causes higher skin surface dose. 73.4% dentists were not aware of the type of collimator used in their X-ray equipment and 26.4% dentists reported the use of round collimator.

11% of dentists were reported that their dental X-ray machines operate between 60 and 70 kilo voltage peak (kVp) and remaining 89% were having no idea about at what kVp their equipment was working.

60.7% dentists had a machine with digital timer and remaining 39.3% had dental X-ray units with conventional timers.

Technique and knowledge about radiation protection

Only 1.2% reported to use paralleling techniques and use of film holders and rest 98.8% dentists used bisecting angle technique and finger as primary means of stabilizing film.

In our study, there were 77.91% dentist who were having <2 m distance between X-ray tube head and control panel and neither had they owned a barrier nor they were aware of position and distance rule.

25.8% of dentist did not know what speed of film they used. 74.2% reported using E-speed film.

1.84% dentists owned lead apron, and none of the study participants had thyroid collar available in their dental clinic.

Discussion

Radiological study is mandatory for dental practitioners and must be performed in such a way that benefits outweighs disadvantages with ALARA principle.[6]

There are certain significant ways to decrease the radiation dose in dental radiography like the use of faster image receptors, film holders, rectangular collimation and also the use of rectangular PID. However, practicing dentists were not able to follow ALARA principle.

The level of knowledge among dentists regarding radiation protection was found to be very weak. There was lack of awareness about radiation protection for their patients as well as for their own protection.

Mutyabule and Whaites in their study have emphasized on CME programs to improve radiation protection techniques and upgrade of radiation protective devices.[7]

In a study conducted by Shahab *et al*.,[8] the majority of dentists included in study were not able to select correct technique and equipment so as to reduce exposure of their patient to secondary radiation.[9]

In our results, we found that many of dentists were not using certified dental X-ray units and relying on cheaper dental X-ray machines from local manufacturers. This neglect has arisen out of lack of awareness regarding radiation protection and not due to economical constraints.

The digital intraoral receptors require less radiation dose to produce images as compared to conventional films.[10-12] The present study shows 38.7% of dentists used this system while remaining still adhere to analog receptor system. A study from Spain reported that 19.3% dentists preferred digital radiography with yearly increase of 4%.[11] Our results (38.7% digital receptors) were in accordance with two reports from Belgium of using digital intraoral imaging (34% and 38%, respectively).[13,14] 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.[10-12]

To ensure the optimum exposure condition, quality assurance tests of dental X-ray units should be performed. In India, AERB mandates that quality assurance tests of dental X-ray units should be carried out every 2 years by certified professionals. Despite this fact our study shows only 36.80% of dentist were aware of this and this lack of awareness may be attributed to lacunae in teaching curriculum regarding maintenance of X-ray equipment and relatively recent AERB mandates about which all dental practitioners are not aware. The maintenance professionals were called in only when there is a problem in the X-ray machine.

To reduce patient exposure, source to skin distance should be increased by the use of appropriate PID, as it causes less divergent X-ray beams and the reduction of the patient's exposure volume. In our study, the majority of dental practitioners (74.2%) were using cylindrical PID, but they were unaware of whether the cylindrical PID was long cone or short cone. The use of long cone is not popular among practicing dentist as many X-ray machine manufactures are providing short or medium cone with X-ray machine, and the long cone is available separately for purchase. 25.8% dentists were still using old fashioned dental X-ray units with cone shaped PID enjoying the freedom from cone cut and totally neglecting the increased skin surface dose.

Restricting the size of X-ray beam can prevent unnecessary patient exposure.[9,10,13] Results of the present study show that the awareness about the fact is very low among the general practitioners. The results were similar to the findings in Belgium (6%),[10] Turkey (5.5%),[13] and Canada (8%).[15] Higher rates were reported in Sweden (36%).[16] The rectangular collimation of radiation beam limits the exposure area by a factor of three to four[17] and reduces the effective dose to almost 60%.[9]

When analyzing the exposure parameters for intraoral radiographic equipment it was found that 89% were having no idea about at what kVp their equipment was working, and 11% of dentist were reported that their dental X-ray machine operate between 60 and 70kVp. This lack of awareness about kVp may 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 7-10 mA and only variable factor is exposure time. The majority of dentists never change exposure time according to subject thickness and area to be radiographed. Many times they were found to increase exposure time to compensate for poor quality X-ray units or weak processing chemicals.

The general use of the digital timer to operate X-ray machine provides higher precision could be reached especially in short exposure time ranges. 60.7% dentists had machine with digital timer.

The use of correct technique results in fewer retakes and minimal patient exposure. In our study, the majority of dentists (98.8%) used bisecting angle technique. This is similar to Iran (88%),[8] Turkey (62%),[10] and Uganda (95%)[7] and finger as primary means of stabilizing film thereby exposing patients hand to primary radiation. Only 1.2% reported using paralleling techniques and film holders.

X-ray machine should be installed in rooms with proper shielding to make sure that public in the surrounding area is not exposed to radiation. The effective shielding is dependent on type of material used and its thickness. Many materials are in use for radiation shielding. However, brick or concrete

Table 3: Reference data on shielding of dental intraoral radiography X-ray installation room.

Shielding material	Distance from center of patient table					
	1.0 m		2 m		4.0 m	
	Primary wall	Secondary wall	Primary wall	Secondary wall	Primary wall	Secondary wall
Brick (cm)	12	5	10	5	8	-
Concrete (cm)	9	4	7	2	5.0	-
Lead (cm)	0.1	0.04	0.08	0.02	0.06	-

are thought to be the best materials due to easy availability, good structural strength and are economical. Lead is in use as radiation shielding material, but it has weak structural strength with tendency to lose uniformity and needs to be checked periodically. Lead is also a serious environmental threat, and its use is decreasing all over the world. Currently, lots of new materials are introduced as an alternative to lead. On demonstration of shielding adequacy, AERB is recommending use of these materials (Table 3).[18]

No single dimension of X-ray room should be <3 m. The thickness of primary wall where primary beam falls should be 35 cm solid brick wall. All secondary walls can be minimum 23 cm or 9 inch brick wall. There should be no windows and ventilations above 2 m from the floor outside. There should be shielding equivalent to at least 23 cm brick or 1.7 mm lead in front of the door to protect the adjacent area. Furthermore, not more than one X-ray unit of any type should be installed in the same room.[18]

The recommended method for operator protection is to use barrier or position and distance rule when the barrier is not available. The distance between operator and X-ray equipment should not be <2 m during exposure. Operators should always use radiation protection devices such as protective apron while operating the X-ray equipment.[18]

In our study, there were 77.91% dentist who were having <2 m distance between X-ray tube head and control panel and neither had they owned a lead barrier or lead apron nor they were aware of position and distance rule. Most dentists stood at the same spot in dental clinic irrespective of the position of X-ray tube head. This may be attributed to many factors like neglect to position and distance rule taught in undergraduate curriculum, cost and space constraints to buy lead barrier and lead apron, high cost of commercial property to open dental clinic where space is just adequate and topmost faith that radiation dose is minimal and not going to harm.

It is the author's general observation that many dentists using digital radiography system do hold sensors for their patients in fear of damaging costly sensors which is actually like playing with fire and leading to damages that are hidden and having long latent period to express themselves.

Significant reduction in the dose of radiation in dental radiography occurs with the usage of faster image receptors.[19-21] 50% of radiation dose can be reduced by replacing the D-speed film with E-speed.[9,15] The use of F-speed film results in a 20% dose reduction compared with E-speed film.[22] In our study, 25.8% of dentist did not know what speed of film they used. 74.2% reported the use of E-speed film which was higher than Greece (66%),[2] Iran (62%),[8] Belgium (40%),[13] Canada (25%),[15] Denmark (25%),[23] Finland (24%),[24] Uganda (22%),[7] Turkey (10.2%),[10] and Spain (0.8%).[11] The use of D- and F-speed film is out of question as they are not readily available in the Indian market and only available film in the market is E-speed film and hence the most unaware dentist is also using E-speed film by chance.

The use of lead apron and thyroid collar was minimal owing to the general tendency that the radiation exposure due to dental X-ray machine is very less. The main role of a lead apron is the absorption of scattered radiation and reduction of the dose received by patients.[25] Our study reported the use of lead apron by 1.84% dentists and no dentist was found using thyroid collar.

Conclusion

Awareness and knowledge of dentists regarding radiation protection were not adequate enough, and there should be the implementation of techniques to improve radiation protection to themselves and patients in routine dental radiography.

The present study had some limitations also. We assessed knowledge level in one of CDE session and our results were under the impact of selection bias. Second, the sample size was not sufficient to compare the results.

The results of the study show that the dentists' awareness and practice of radiation protection techniques are not satisfactory. Hence, more emphasis should be placed on radiation hazards and radiation protection techniques in undergraduate and post-graduate curriculum and CDE programmes. Every dentist should purchase certified dental X-ray equipment and should compulsorily follow mandate for regular quality assurance test of X-ray units including periodic check-up of films, processing chemicals and darkroom lighting to maintain a high level of radiographic quality with fewer exposures in favor of patients and themselves.

References

1. Horner K. Review article: Radiation protection in dental radiology. Br J Radiol 1994;67(803):1041-9.
2. Syriopoulos K, Velders XL, van der Stelt PF, van Ginkel FC,

Tsiklakis K. Mail survey of dental radiographic techniques and radiation doses in Greece. Dentomaxillofac Radiol 1998;27(6):321-8.
3. Wingren G, Hallquist A, Degerman A, Hardell L. Occupation and female papillary cancer of the thyroid. J Occup Environ Med 1995;37(3):294-7.
4. Eriksson M, Hardell L, Malker H, Weiner J. Increased cancer incidence in physicians, dentists, and health care workers. Oncol Rep 1998;5(6):1413-8.
5. Rix BA, Lynge E. Cancer incidence in Danish health care workers. Scand J Soc Med 1996;24(2):114-20.
6. American Dental Association Council on Scientific Affairs. The use of dental radiographs: Update and recommendations. J Am Dent Assoc 2006;137(9):1304-12.
7. Mutyabule TK, Whaites EJ. Survey of radiography and radiation protection in general dental practice in Uganda. Dentomaxillofac Radiol 2002;31(3):164-9.
8. Shahab S, Kavosi A, Nazarinia H, Mehralizadeh S, Mohammadpour M, Emami M. Compliance of Iranian dentists with safety standards of oral radiology. Dentomaxillofac Radiol 2012;41(2):159-64.
9. White SC, Pharoah MJ. Oral Radiology Principles and Interpretation, 6th ed. St. Louis, MO: Mosby; 2009.
10. Ilgüy D, Ilgüy M, Dinçer S, Bayirli G. Survey of dental radiological practice in Turkey. Dentomaxillofac Radiol 2005;34(4):222-7.
11. Alcaraz M, Parra C, Martínez Beneyto Y, Velasco E, Canteras M. Is it true that the radiation dose to which patients are exposed has decreased with modern radiographic films? Dentomaxillofac Radiol 2009;38(2):92-7.
12. Christensen GJ. Why switch to digital radiography? J Am Dent Assoc 2004;135(10):1437-9.
13. Jacobs R, Vanderstappen M, Bogaerts R, Gijbels F. Attitude of the Belgian dentist population towards radiation protection. Dentomaxillofac Radiol 2004;33(5):334-9.
14. Aps JK. Flemish general dental practitioners' knowledge of dental radiology. Dentomaxillofac Radiol 2010;39(2):113-8.
15. Bohay RN, Kogon SL, Stephens RG. A survey of radiographic techniques and equipment used by a sample of general dental practitioners. Oral Surg Oral Med Oral Pathol 1994;78(6):806-10.
16. Svenson B, Petersson A. Questionnaire survey on the use of dental X-ray film and equipment among general practitioners in the Swedish Public Dental Health Service. Acta Odontol Scand 1995;53(4):230-5.
17. Sitra G, Daniel MJ, Srinivasan SV, Prashad KV. Radiation protection protocol observed among dentist population in the union territory of Puducherry. J Indian Acad Oral Med Radiol 2008;20:45-8.
18. Available from: http://www.aerb.gov.in/AERBPortal/pages/English/t/XRay/forms/layout_guidelines.pdf. [Last accessed on 2015 Sep 02].
19. Thunthy KH, Weinberg R. Sensitometric comparison of Kodak EKTASPEED Plus, ektaspeed, and ultra-speed dental films. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79(1):114-6.
20. Peterson CA, Mauriello SM, Overman VP, Platin E, Tangen CM. Effects of beam collimation on image quality. J Dent Hyg 1997;71(2):61-70.
21. Svenson B, Welander U, Shi XQ, Stamatakis H, Tronje G. A sensitometric comparison of four dental X-ray films and their diagnostic accuracy. Dentomaxillofac Radiol 1997;26(4):230-5.
22. Syriopoulos K, Velders XL, Sanderink GC, van Der Stelt PF. Sensitometric and clinical evaluation of a new F-speed dental X-ray film. Dentomaxillofac Radiol 2001;30(1):40-4.
23. Hintze H. Radiographic screening examination: frequency, equipment, and film in general dental practice in Denmark. Scand J Dent Res 1993;101(1):52-6.
24. Havukainen R. Survey of dental radiographic equipment and radiation doses in Finland. Acta Radiol 1988;29(4):481-5.
25. Kaviani F, Esmaeili F, Balayi E, Pourfattollah N. Evaluation of X-ray protection methods used in dental offices in Tabriz in 2005-2006. J Dent Res Dent Clin Dent Prospects 2007;1(1):49-52.