Original Article

Attitude of General and Specialist Dental practitioners towards Radiation Safety Principles

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Abstract

Introduction: The objective of this study was to determine the attitude of dental practitioners towards radiation protection principles and radiographic techniques. We aimed to assess whether dentists' specialty and university membership impacted the conducts of radiologic practice. **Methods:** A total of 232 dental offices with intraoral radiographic devices in Mashhad, Iran were randomly selected. Demographic characteristics of dentists as well as radiographic equipment and techniques were recorded. Participants were grouped according to specialty and faculty membership. Chi-square tests were used for statistical analysis and comparison of groups by Statistical Package SPSS v.23. **Results:** 190 dentists (81.9%) were in general dental practice (GDP) and the remaining 42 (18.1%) worked as specialists in different fields. A significant difference was noted regarding the use of digital sensors between general and specialist dentists (16.8% vs. 35.7%, respectively). Paralleling technique using film holders was employed by 28.6% of specialists and 10% of the general dentists ($p<0.05$). Half of the specialists used routine thyroid shielding; however, only 28.4% of the GDPs followed this practice ($p<0.05$). Among the specialists, 19 (45.2%) had faculty membership. Use of a rectangular collimation, long cone, and thyroid shield, except variable exposure time were more common in non-faculty members, although not significantly different. **Conclusion:** Although most dentists did not follow the standard radiological guidelines, it was noticeable that specialist dentists used more appropriate radiographic techniques. Attention should be focused on under- and postgraduate education and employing strict policies for dental radiologic safety measures.

Keywords: Dental offices, Radiography, Dentist, Radiation protection

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Introduction

Radiography is a necessary tool for treatment recognition, planning and efficacy. The information provided by the radiography is for the patients' benefit, although the exposure is considered to be potentially harmful (1). More than 330 million dental imagings are performed annually, most of which are intraoral examinations (2). The radiation dose might be low for each examination, but patients are exposed to repeated examinations during dental follow-ups (3). The long-term health effects of low dose exposures is uncertain (4); however, studies show an association between radiation exposures and incidence of salivary gland and thyroid cancers, and intracranial meningioma (5-7). Principles on the use of ionizing radiation exist in Iran, although little data is available on how they are applied in the dental field. It is important to adhere to the "as low as reasonably achievable principle" (ALARA) and maintain minimal exposure (8). It is possible to improve image quality along with reduced radiation dose if dentists follow the standard radiographic safety principles. The American Dental Association recommends the use of fast

image receptors (F speed film or digital), beam limitation best achieved by rectangular collimation, personnel dosimeters and lead aprons, and thyroid collars when appropriate (9).

Nowadays intraoral radiography devices are being routinely used by general and specialist dentists. The influence of factors such as dental specialty and faculty membership on radiographic practice has rarely been studied in Iran. The objectives of this study were to determine the radiographic techniques and facilities used by dental practitioners and to assess whether dentists' specialty and faculty membership impacted the choice of the intra-oral receptor, collimation method, image acquisition techniques, or methods of shielding. Determining the knowledge of our dentists and their implementation towards radiation safety measures, will insure the management of future academic programming, and monitoring strategies.

Materials and Methods

A total of 232 private dental offices with intraoral radiographic devices in Mashhad, Iran were randomly selected. The study protocol was approved by the institutional review committee. Radiation safety standards according to ADA recommendations during dental radiographs were considered (9). Demographic characteristics of dentists as well as radiographic equipment including image receptors, collimation, film holders, protection methods for patient and personnel, and bisecting or paralleling techniques were recorded in a checklist. The dental practitioners' confidentiality was maintained. The respondents were classified into two groups including general dental practitioners (GDPs) (n=190) and dental specialists (n=42). Dental specialists were then grouped into faculty members and non-members. Frequency tables were provided according to the data and the statistical analysis was performed by Statistical Package for the Social Sciences (SPSS v.23). Chi-square test was used to determine the significance of differences between two independent groups at P=0.05 level.

Results

Demographic Data

Of the 232 dental practitioners, 190 (81.9%) dentists were in general dental practice (GDP) and the remaining 42 (18.1%) worked as specialists in different dental fields. 22 (52.4%) of the specialists were endodontists and the rest qualified in other fields. Males comprised 135 (71.1%) of GDPs and 26 (61.9%) of the specialists. The average age of all participants was 43.8 ± 8.5 years (range 26-70 years). The majority of GDPs (50.9%) had practiced dentistry for 10-20 years, 22.3% had below 10 years of practice and 26.9% had practiced for over 20 years. Whilst, most specialists (57.1%) had below 10 years of practice, 28.6% practiced for 10-20 years and 14.3% for over 20 years. Among the specialists, 19 (45.2%) had faculty membership.

Radiographic Equipment and Techniques

The E-speed film was used by 179 (77.1%) dentists while digital sensors were used by 47 (20.3%) and 6 (2.6%) dentists used both receptors. None of the dentists used F-speed films. Of the 47 dentists using digital sensors, 32 (68.1%) were GDPs. Regarding the use of image receptors, the study found a significant difference ($P<0.05$) between the two groups with 15 (35.7%) specialists using digital sensors compared with 32 (16.8%) GDPs. The results of the kVp settings show that the majority of both general and specialists' dentists operate at 60-70 kVps. 37 specialists (88.1%) and 157 (82.7%) of GDPs reported using an X-ray device with a long-cone providing a 20 cm or greater focus-to-object distance. Overall, the majority of dentists (87%) used round collimation and only 7.3% of the dentists used rectangular collimation. The type and length of collimation utilized did not vary significantly between GDPs and specialists. Paralleling technique using film holders was employed by 28.6% of specialists and 10% of the general dentists ($p<0.05$). 32 (76.2%) specialists and 149 (78.4%) GDPs reported that they undertake the radiography themselves.

The frequency of image receptors, type and length of collimation, film holder usage, kVp settings and the radiographic technique (parallel and/or bisecting angle) in comparison between general and specialist dental practice are shown in Table I.

Table I The frequency of radiographic equipment and techniques in general and specialist dental practice

Equipment and Technique	Participants		P-value*
	General Dentist N=190 (%)	Specialist N=42 (%)	
Image receptor			0.002
• E-speed film	155 (81.6)	24 (57.2)	
• Digital sensor	32 (16.8)	15 (35.7)	
• Both	3 (1.6)	3 (7.1)	
kVp setting			0.202
• <60	0 (0.0)	0 (0.0)	
• 60-70	175 (92.1)	41 (97.6)	
• >70	15 (7.9)	1 (2.4)	
Collimation length			0.38
• Short	33 (17.3)	5 (11.9)	
• Long (>20cm)	157 (82.7)	37 (88.1)	
Collimation type			0.73
• Rectangular	16 (8.4)	1 (2.4)	
• Round	161 (84.8)	41 (97.6)	
• Pointed	13 (6.8)	0 (0.0)	
Use of Film holder			0.006
• Routine or if required	32 (16.8)	15 (35.7)	
• Never	158 (83.2)	27 (64.3)	
Radiographic technique			0.005
• Paralleling	19 (10.0)	12 (28.6)	
• Bisecting angle	158 (83.2)	27 (64.3)	
• Both	13 (6.8)	3 (7.1)	

* Significance is established between two columns for each variable (Pearson's chi-square test)

Patient and Personnel Protection

In general, 75 (32.3%) and 73 (31.5%) dentists used thyroid shields, and lead aprons respectively, in their

practice for all patients and 14 (0.6%) and 32 (13.8%) used them only for pregnant women and children.

Half of the specialists utilized regular thyroid shielding; however, only 28.4% of the GDPs followed this practice (P<0.05). When evaluating the use of lead aprons, there was a significant difference between the specialists and GDPs. Of the former, 15 (35.7%) reported that lead aprons were used regularly, whilst 12 (28.6%) use them occasionally. 58 (30.5%) GDPs stated that lead aprons were used regularly, while 20 (10.5%) occasionally used them (Table II).

Table II The frequency of patient and personnel protection methods in general and specialist dental practice

Protection method	Participants		P-value*
	General Dentist	Specialist	
	N=190 (%)	N=42 (%)	
Thyroid shield			0.001
• Regularly	54 (28.4)	21 (50.0)	
• Occasionally	7 (3.7)	7 (16.7)	
• Never	129 (67.9)	14 (33.3)	
Lead Apron			0.003
• Regularly	58 (30.5)	15 (35.7)	
• Occasionally	20 (10.5)	12 (28.6)	
• Never	112 (59.0)	15 (35.7)	
Personnel Protection			0.001
• Lead wall	13 (6.8)	9 (21.4)	
• Lead partition	82 (43.2)	28 (66.7)	
• Position & distance	67 (35.3)	3 (7.1)	
• None	28 (14.7)	2 (4.8)	
Exposure time			0.187
• Fixed	133 (70.0)	25 (59.5)	
• Variable	57 (30.0)	17 (40.5)	

* Significance is established between two columns for each variable (Pearson's chi-square test)

Overall, 202 (87.1%) dentists used either the position and distance rule or a lead barrier for their own protection. 30 of the dentists did not use any personnel protection method. Specialist dentists showed a higher (88.1%) use of the lead wall/partition for their personnel protection. Statistically, a significant difference was found between GDPs and specialists regarding the use of any personnel protection method (p<0.05). Although not significantly different, 40.5% of the specialists changed the exposure time properly for different patients compared to 30% in the GDPs. (Table II)

Influence of Faculty Membership

19 (45.2%) specialists held faculty membership. To test whether radiographic practice differed with faculty membership, specialist dentists were grouped according

to faculty membership and Chi-square tests were carried out. Non-faculty members used lead aprons more often ($p<0.05$) than faculty members. Use of a rectangular collimation, long cone, and thyroid shield, except variable exposure time were more common in non-faculty members, although not significantly different (Table III). The percentage of radiographic exposures conducted by a dental nurse was reported as ranging from 15.8% in faculty-members to 30.4% in non-members.

Table III The frequency of radiographic equipment and protection methods in specialist dental practice

Equipment & Protection Method	Specialist Membership		P-value*
	Faculty N=19 (%)	Non Faculty N=23 (%)	
Image receptor			0.618
• E-speed film	10 (52.6)	14 (60.9)	
• Digital sensor	7 (36.8)	8 (34.8)	
• Both	2 (10.5)	1 (4.3)	
Collimation length			0.378
• Short	4 (21.1)	1 (4.3)	
• Long (>20cm)	15 (78.9)	22 (95.7)	
Collimation type			1.000
• Rectangular	0 (0.0)	1 (4.3)	
• Round	19 (100)	22 (95.7)	
• Pointed	0 (0.0)	0 (0.0)	
Use of Film holder			0.345
• Routine or if required	8 (42.1)	8 (34.8)	
• Never	11 (57.9)	15 (65.2)	
Radiographic technique			0.698
• Paralleling	6 (31.6)	6 (26.1)	
• Bisecting angle	11 (57.9)	16 (69.6)	
• Both	2 (10.5)	1 (4.3)	
Thyroid shield			0.679
• Regularly	8 (42.1))	13 (56.5)	
• Occasionally	4 (21.1)	3 (13.0)	
• Never	7(36.8)	7 (30.4)	
Lead Apron			0.041
• Regularly	3 (15.8)	12(52.2)	
• Occasionally	8 (42.1)	4 (17.4)	
• Never	8 (42.1)	7 (30.4)	
Personnel Protection			0.752
• Lead wall	5 (26.3)	4 (17.4)	
• Lead partition	12 (63.2)	15 (65.2)	
• Position & distance	1 (5.3)	3 (13.0)	
• None	1 (5.3)	1 (4.3)	
Exposure time			0.542
• Fixed	10 (52.6)	15 (65.2)	
• Variable	9 (47.4)	8 (34.8)	

*Significance is established between two columns for each variable (Pearson's chi-square test)

Discussion

Many equipment and techniques for achieving the minimum dose and maximum radiographic efficiency have been widely and inexpensively available for decades, although they are not explicitly considered (2, 10). Many studies show that dentists do not completely adhere to the ALARA principles. By using digital sensors or F-speed film instead of D-speed film, combined with rectangular collimation instead of round collimation, dentists can reduce patients' exposure by a factor of 10 for intraoral radiography (1). The digital imaging for intraoral radiography needs significantly lower radiation than conventional films and produces largely comparable images (2, 8, 11). It was disappointing to record that only 16% of the general practitioners and 35.7% of the

specialists used digital receptors. Reports from Syria, Turkey, Spain and Belgium indicated that approximately 1%, 14%, 19.3% and 38% of dental practitioners used digital imaging, respectively (11-14). The low rates may be attributed to the high cost of equipment and patient discomfort owing to inflexible receptors. Despite this, a higher use of digital intraoral imaging was reported in Korean dentists (77.2%) (3). Similar to our study, Orafi et al. found a significant difference between the use of digital radiography by specialist endodontists (70.5%) compared to general dental practitioners (27.7%) (15). In Iran, no reports have been found to indicate the difference between general and specialist dentists in this regard. Lack of knowledge and difficulty in mastering digital image acquisition and processing may be the reasons for the limited use of digital receptors in general dentists in our study.

The length and shape of the x-ray beam have the most important roles in determining the patient dose in dental radiography (14). According to the National Council on Radiation Protection, a rectangular collimator can reduce radiation exposure by about 60% (16). The use of rectangular collimation was limited, in regard to recent studies from Iran and other countries (17-19). There were also no significant differences in the use of rectangular collimation between GDPs (8.4%) and specialists (1.4%). A previous study reported differences between specialists and general dentists with regard to the use of rectangular collimation (15). The limited usage of rectangular collimation might be due to concerns about cone cutting and the belief that collimation is an inherent component of device (3). Moreover, as rectangular cones need to be purchased separately, practitioners may be unaware of their benefits. Studies suggest that specialists are more knowledgeable about radiation principles; however, even specialists have little attention to rectangular collimation.

Use of a short cone with a focus-to-object distance of 100 mm instead of a long cone (200 mm) increases the effective dose of a radiographic exposure by a factor of 1.5 (20). Long cone results in less divergent X-ray beams and a reduction in tissue exposure volume (21). The majority of specialists (88%) and GDPs (82.7%) used intraoral devices with a long cone. These figures were higher compared to a study from Iran (15%) as well as studies from Turkey (52.3%), England and Wales (63%) and USA (50.5%) (11, 22-24). However, a study in Spain reported that 90.7% of the intraoral devices were equipped with a long cone (12).

The bisecting angle technique is an old method for periapical radiography. The paralleling technique has a comparatively better performance. Appropriate film holders are essential to the paralleling technique. The use of film holders improves the diagnostic quality of intra-oral radiographs, reduces the number of rejected films, and avoids unnecessary exposure to patients' fingers (25). Comparable to a previous report from Iran and India about 20% of the dentists used film holders (19, 26). Although a minority of dentists in this study used film holders, significant differences were noted between specialists (28.6%) and GDPs (10%) in this regard. Similarly, Orafi et al. (15) reported significant differences in the use of these instruments between the endodontic specialists and GDPs. However, a previous study conducted in Iran showed no significant difference between general practitioners and specialists regarding the use of film holders (22). These findings suggest that there is a lack of knowledge on the use of film holders when employing the paralleling technique, which may be attributed to lack of appropriate training opportunities.

Thyroid shields and lead aprons are patient-protective equipment that reduce radiation exposure to the thyroid gland and gonads, respectively (3, 8). Compared to a study from India that reported 90.3% of the GDPs were not providing any safety measures for their patients, we found better performance in this regard (26). Our study showed that 50% of the specialists and 28.3% of GDPs utilized thyroid shielding regularly. In addition, 35% of specialists and 30% of GDPs draped lead apron over all patients. These differences were significant and indicated a high rate of neglect in this regard, especially in general practitioners. Previous studies have also reported higher rates of apron/thyroid shielding in specialists practice compared to GDPs (3, 22). A recent study in Saudi Arabia showed that compared to GDPs and endodontists, undergraduate students and endodontic postgraduate students were better at following protection guidelines in regard of apron and thyroid lead shielding (27). Furthermore, their study showed that dentist working in academic and governmental sectors were more likely to use apron and thyroid lead shielding (27).

The preferred method for operator protection is to use a protective barrier or to leave the room during radiographic exposure (28). A recent study in Australia reported that two-thirds of the dentists stood behind a protective barrier during exposure (29). In the present study, lead partition was the most commonly used method for environment protection in both general and specialist dental offices. Unfortunately, 14.7% of GDPs and 4.8% of specialists did not use any methods for their own protection.

Selecting an appropriate exposure time is very important in minimizing patients' radiation exposure. According to our results, 40.5% of specialist and 30% of GDPs

reported that they changed the exposure time for different patients, which was similar to the findings of Shahab et al. (49%) (22). Igluy et al. reported that 70.3% of dentists (general and specialist) set the exposure time according to the location of the tooth (11).

Conclusion

The majority of dentists in this study did not follow the standard radiation protection guidelines. However, it was noticeable that specialist dentists were more likely to use optimal radiographic practice such as digital sensors and paralleling technique with film holders than general dental practitioners. This emphasizes the need for more efficient under- and postgraduate education and strict policies for employing dental radiologic safety measures.

Conflict of Interest

No potential conflict of interest relevant to the present research was reported.

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