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EVALUATION OF RADIATION PROTECTION PRINCIPLES OBSERVANCE IN DENTAL RADIOGRAPHY CENTERS (WEST OF IRAN): CROSS-SECTIONAL STUDY

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The aim of this study is to assess the evaluation of radiation protection principles observance in dental radiography centers and hazards. This cross-sectional study was designed to assess level of radiation protection principles in dentistry centers. The present cross-sectional study was conducted by enrolling 103 dentistry centers in Kermanshah province (west of Iran). Our finding illustrates 75.7% of the centers were equipped with an intraoral radiography. Although observance principles of radiation protection for patient at dentistry center were at appropriate level (97.3%), the observance of the protective principles was not adequate for the skilled workers in any center. The most commonly used protective measure was the observance of a distance from patient (97.3%) and the minimum protective measures such as the use of high-speed film (1.4%). According to results in this study, the knowledge and practice of radiation protection are not satisfactory.

BACKGROUND

Dental radiology is one of the most widely used diagnostic modalities in the diagnosis of dental diseases[1]. There are many concerns about stochastic effects of ionising radiation, especially in dental radiography[2]. However, the risk of primary cancers of ionising radiation in dental radiographies is very low, but the cumulative dose associated with it is very important and should be evaluated[3]. Knowledge about radiation doses and hazards is very important, and radiological examinations play a crucial role in medicine[4]. United Nations Scientific Committee on the Effects of Atomic Radiation 2000 reports that dental radiography is one of the radiological procedures that are performed frequently[5]. So, the US Food and Drug Administration, the American Dental Association and the European Commission (EC) have proposed guideline for patient selecting and reduce radiation exposure[6, 7]. Recent reports have raised concern about the increased use of ionising radiation in dental imaging and the possibility of cancers[8]. Although radiation exposure due to dental radiographs is relatively low, radiological methods should be according to As Low As Reasonably Achievable—optimised to minimise the risk of radiation exposure[9–11]. According to previous reports, cone beam computed tomography radiation dose is significantly higher than dose from conventional dental radiographs[12, 13]. Although radiography is an indispensable diagnostic tool for the diagnosis of oral and dental lesions, the effective doses of dental radiography techniques are high enough to provide recommendations for reducing radiation risk[14]. By following the simple principles of radiation protection and applying appropriate protective equipment by radiographers, it is possible to greatly reduce unwanted, excessive and unnecessary dose to patients, staff and, ultimately, the community. Therefore, due to the lack of information, this study has evaluated the observance of radiation protection principles in Kermanshah dental centers.

MATERIALS AND METHODS

Number of samples

Since the studied variables are studied through a questionnaire and the size of the statistical population is low[15], the following formula is used to obtain the sample size from equation[1]:

$$n = \frac{N\left(z_{1-\frac{\alpha}{2}}\right)^2 \times \sigma^2}{(N-1)\,d^2 + \left(z_{1-\frac{\alpha}{2}}\right)^2 \times \sigma^2} \quad (1)$$

Here, n is the required sample size, N total of population and α is the 95% confidence level, which is

usually considered in the 5% research. In other words, with this sample size calculated from this formula, the accuracy of the information at 95% confidence level and 5% error is valid. Based on a preliminary sampling (pre-test), variance was estimated. After determining the variance, accuracy and confidence, the number of samples was calculated:

$$n = \frac{276 \times \left(1.96^2\right) \times 0.57^2}{275 \times (0.087)^2 + (1.96)^2 \times 0.57^2} = \frac{344}{3.32} = 103 \quad (2)$$

Validity and reliability

To evaluate the content validity in a quantitative way from two coefficients, content validity ratio (CVR) and content validity index (CVI) were used. First, to determine the CVR from the panel of experts consisting of 15 radiologists, medical physicians and experts with experience in radiology, it is requested to examine each question in a questionnaire based on the three-part spectrum (it is useful, but not necessary). Then, the CVR value was calculated based on the following equation[2]:

$$\mathrm{CVR} = \frac{n_E - N/2}{N/2} \quad (3)$$

In the formula, n_E is the number of experts who are an indispensable option, and N is the total number of experts, of which 15 are in the research. The calculated CVR for each question based on the Lawshe table for 15 people should be >0.49. For all the questions used in the questionnaire of this research design, this test was performed and the calculated CVR for each question was >0.49. Then, to determine the CVI, three criteria for simplicity, specificity and clarity were examined as a four-part Likert scale for each of the questions by the 15-member experts, the CVI score by aggregating the concessions for each question. The third and fourth grades were calculated on the total number of specialists, while the admission rate was based on a score of above 0.79.

To test the reliability of the questionnaire, the Cronbach's test (adjusted) was used. The reliability obtained in this study was 0.84 using the Statistical Package for the Social Sciences (SPSS) software and the alpha coefficient showed that the questionnaire used in this study was of high reliability. After assessing the validity and reliability of the questionnaire in this study, a field survey was conducted using a questionnaire. Using a statistical compilation of 276 medical dental centers in the west of Iran, 103 medical dental centers were selected to complete this questionnaire.

Sampling

This descriptive cross-sectional study was performed on 103 dental centers in Kermanshah province (west of Iran), which participated voluntarily in this study. The information form and the list consistent (includes 17 questions) with the principle of radiation protection were designed based on the recommendations of radiation protection organisation in dentistry[16, 17]. The questionnaire was conducted regarding the EC[17] and the National Radiological Protection Board (NRPB)[18] recommendations about radiation protection in dental radiography[21]. The first part of the study was conducted on the demographic characteristics of the radiographers and dental centers; the second part included a checklist on two areas of protection of patients and radiographers. Observing the protective parameters by radiographer and using the required protective equipment, the score is one, otherwise the score is zero. Overall, the score of 12–17 was considered as the appropriate level for protective principles, 6–11 average and 0–5 weak. Centers were identified and the protective function of radiographers was assessed.

Statistical analysis method

In this research, descriptive and inferential statistics were used to analyze the data. Data were analyzed using SPSS18 software. The results were presented using descriptive statistics including mean and variance for quantitative and frequency variables and percentage for qualitative variables. The researcher also used the Chi-square test for some of the complementary comparisons and analytical results. The significance of the test was considered $p < 0.05$.

RESULTS

Out of 103 dentistry centers in Kermanshah province 78 centers had intraoral radiography (IR). Seventy-three private dentistry centers (93.6%) and five public dentistry centers (6.4%) have participated in this study. Only 4%[3] of dentistry centers used digital imaging systems among these centers. There were no lead aprons in private centers. Also, automatic processor for film processing was not used at any of the centers and there was no systematic quality control program for radiographic devices. The results of this study showed that the overall level of radiation protection in the studied centers was moderate, and only two centers had adequate protective function. The most commonly used means of protection was to observe a minimum distance of 2 m from the patient during exposure (97.3%), and the use of film badge to reduce the exposure to the patient in these centers was dramatically low (6.8%). Also, the findings showed

Table 1. Observance of radiation protection principles for patient and radiation workers in dentistry centers with intraoral radiographic equipment (number and percentage of centers).

Protection proceedings N (%)				
Film type	E-speed film 65(87.8)	D/E-speed film 5(6.8)	F-speed film 3(4.1)	
Protective covers	The use of lead apron to pregnant patients or children 9(12.2)	Use thyroid shield 9(12.2)	The use of leaded paravan 37(50)	
Position-indicating devices type	Rectangular 4(5.4)	Cylindrical 70(94.6)	Use the length of the collimator over 18 cm 68(91.2)	
Exposure room protection	Leaded walls 6(8.1)	Use X-ray warning signs 5(6.8)	Appropriate angle to central beam 71(95.9)	Proper wall thickness 56(75.7)
Individual protection	Use individual dosemeters 5(6..8)	Use the film holder 6(8.1)	Proper distance from the patient 72(97.3)	

Table 2. Status of dose-saving practices in IR practices in Kermanshah province (number and percentage of centers).

Frequency	Protection proceedings	Frequency	Protection proceedings
72(97.3%)	Compliance of distance (2 m) from the patient	6(8.1%)	Presence of lead walls
5(6.8%)	Use individual dosemeters	37(50%)	Lead apron only
56(75.7%)	Wall thickness (15 cm) in the radiation path	71(95.9%)	90–135 angle relative to the central beam

Table 3. Status of dose-saving practices in IR practices and relationship with the type of occupation and work of radiologists in Kermanshah province (number and percentage of centers).

Work experience (y)			Type of job			Compliance level of radiation protection
>20	11–20	1–10	Secretary	Hygiene of oral and dental care	Dentist	
4(100%)	28(93.3%)	39(97.5%)	12(100%)	2(100%)	58(96.7%)	Medium
0	2(6.7%)	1(2.5%)	0	0	2(3.3%)	Suitable

that radiation protection observance for radiation workers in none of the centers was adequate Table 1).

The findings also showed that the level of protection against radiographs in any center was not adequate. In this area, the highest and the least protective measures were observed, including the placement of radiographs at a tolerable distance of 2 m from patients during radiography in 97.3% of the cases and the use of film badges by 6.8% of radiographers (Table 2).

The results also showed that the highest level of radiation protection was observed during radiologic tests performed by dental radiologists (3.3%) and radiographs with 11–20 y of age (6.7%) (Table 3).

The highest radiation protection standards were observed during radiologic examinations by radiographers with work experience of 11–20 y (Table 4). The findings showed that observance of protective measures was only appropriate in centers with <20 radiographies per week and also in private centers.

DISCUSSION

The purpose of dental radiography of the teeth is to achieve a high-quality image of the oral and maxillofacial structure with minimal exposure to the patient. So, next consideration should be given to increasing the use of X-ray diagnostic devices. According to radiation protection protocols[21], our findings about compliance with the principles of radiation protection in dental radiography are slightly better than those mentioned in other studies[19, 20, 21]. Based on the findings of this study, out of 103 dental centers in Kermanshah, 75.7% of the centers were equipped with IR. Most dentists were not familiar with the

Table 4. Status of dose-saving practices in IR practices and relationship with number of radiographs per week and the number of radiographers and the type of ownership in the centers in Kermanshah province (number and percentage of centers).

Ownership		Gender of radiographers		Number of patients			Compliance level of radiation protection
Public	Private	Female	Male	>20	11–20	<10	
2(1.9%)	67(98.1%)	27(100%)	45(95.7%)	18(100%)	30(96.5%)	24(96.0%)	Medium
0	5(100%)	0	2(4.3%)	0	1(3.2%)	1(4%)	Suitable

technical specifications of their equipment. The results showed that the overall radiation protection measures were 97.3% in dental centers. According to the findings of this study, this level of protection is inadequate and should be promoted by fully applying the international radiation protection recommendations and regulations and modern radiology equipment in dental centers. The lowest level of protection for patients in the centers was in the use of ultrafast films. The use of a rectangular collimator three to five times more than circular collimators is more effective in reducing the radiation dose of patients during dental radiography[9]. In this study, rectangular collimator was used in 4.5% of dental imaging centers. Meanwhile, rectangular collimator was used in radiography center in Kaviani (10%)[10], Ghazi Khanloo (11.1%)[21] and Iligo and Jacob (0%) studies[12, 13]. With regard to the effective role of rectangular collimator in protecting patients, the use of this type of collimators was not welcomed by dental centers, which could be due to difficulty and time-consuming in use of this type of collimators compared to the circular types. In this study, none of the centers used dental film processors. It seems that the lack of automatic processors in these dental imaging centers was due to the low frequency of radiography, the high cost of purchasing, maintenance and the need for regular cleaning of these systems. Digital dental radiography systems reduce the radiation exposure of dental radiography by 30–35%. This study shows that only 1.4% of centers used digital radiography system, which is consistent with the results of Kaviani, Ilguy and Aroua studies[10, 12, 14]. Using shields to protect sensitive organs such as thyroid can be very helpful[18]. Although the use of lead aprons or thyroid collar shields in panoramic radiography is highly controversial, none of the dentistry centers used them in this study[19, 20], there were no lead aprons in private centers in this study. The study also showed that all centers employed rare earth intensifying screens in extraoral radiography, similar to the results of other studies[10, 12, 21]. The official recommendations of the European Union and the NRPB suggest that the use of a filter with filtration thickness of at least 1.5 mm Al significantly reduces the patient radiation exposure[20, 21]. Our findings showed that all intraoral and extraoral X-ray equipment's devices use this amount of filtration[10, 12, 21]. This aspect has not been considered in other similar studies in Iran.

CONCLUSION

According to the findings of this study, overall, radiation protection measures in IR by radiographs are not organised, implemented or monitored, and it is far from the standards and recommendations. These conditions could be due to negligence and lack of awareness of dental radiographers and dentists about the potential dangers of X-rays used in dentistry, the lack of adequate supervision of the protection of these centers by health authorities and the lack of continuing education in radiation protection. Setting up guidelines for working with X-ray tubes is essential in dental centers.

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