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Evaluation of Compliance of Panoramic Radiography Prescription with US Food and Drug Administration (FDA) Guidelines among Dentists in an Iranian Population in 2019

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Abstract

Aim: Panoramic radiography is one of the most commonly used radiographs in dentistry, but the dentist is only allowed to prescribe panoramic radiography for the patient with a compelling reason. The aim of this study was to determine the compliance of panoramic radiography prescription with FDA guidelines among general dentists in Kashan, Iran.

Materials and Methods: In this descriptive cross-sectional study, 100 general dentists were selected by census method. A questionnaire including background variables and 27 questions related to the prescription or not prescribing of panoramic radiography was prepared according to FDA criteria and made available to dentists. Data were analyzed using SPSS software 22.0by chi-square and regression tests at the significant level of 5%.

Results: A total of 93 dentists participated in this study, 33 of whom were female and 60 were male, with a mean age of 41.5 to 9.2 years and a mean years of 1 ± 8.9 passed from their graduation. According to the results of the regression analysis, dentists in 78.5% of the first dental visits, 63.4% of the primary dental caries, 78.5% of the initial periodontal examinations, 91.4% of the cases evaluated for growth and development before 6 years of age, 74.2% of determining the anterior alveolar crest height, 82% of determining the posterior alveolar crest height, 50.5% of cases because of the ease of use, 50.5% of cases because of availability, 51.6% of cases due to concerns about the effects of radiation carcinogenesis, 83.9% of cases in pregnant patients, 53.8% of patients in good health, 69.9% of patients with poor health, 51.6% of cases by patient requests, and 52.7% of cases because of concerns about not having radiographs in patient's file legally prescribed panoramic radiographs that did not meet FDA standards, so more than 50% of dentists prescribe panoramic radiographs when it is not in compliance with FDA guidelines.

Conclusion: Prescribing panoramic radiographs among general dentists in Kashan in some cases does not comply with the FDA guidelines for prescribing panoramic radiographs and further education and supervision is recommended.

Keywords: *American Dental Association; Panoramic Radiography; Food and Drug Administration*

Introduction and Problem Statement

In medical sciences and dental medicine, the essential part in the treatment of diseases is the correct diagnosis. Due to limitations, clinical examinations alone cannot be effective in the diagnosis of diseases, so paraclinical examinations should be used. One of the most important paraclinical tools is radiography [1,2].

Panoramic radiography is one of the most commonly used radiographs in dentistry [3]. It is a technique for obtaining a single tomographic image of facial structures including both maxilla and mandibular arches and their supporting structures. Because of ease of use, panoramic radiography has been widely used in screening and epidemiological studies.

Since the introduction of panoramic radiographs to dentists, radiography has been a valuable tool in the diagnosis of maxillofacial lesions [4,5]. Since all teeth, alveolar bone, temporomandibular joint and surrounding structures are easily visible in this radiograph, this radiograph is used for routine screening of patients in various dental centers [6,7].

Panoramic radiography has many benefits: including ease of using the technique in patients, usability and being an alternative to periapical radiography in patients with severe nausea reflex who do not tolerate intraoral film and extensive coverage of maxillofacial structures. Panoramic is also a simpler, faster, cheaper, more convenient method with a lower dose of radiation than the full mouth periapical method [4]. Despite its benefits, panoramic radiographs are less accurate in detecting decay than intraoral radiographs, and image resolution in the anterior jaw areas due to superimposition of the spine in this radiograph is less than intraoral radiographs [3].

Therefore, in parallel with the increasing prevalence of diagnostic X-ray abnormalities, regarding the patient's exposure to X-rays and the effects of X-rays on the patient's body, it is important to observe the principle of safety which protects against adverse effects of this radiation. One of the most effective ways to reduce the potential risk of X-rays is to avoid unnecessary radiographs.

According to the Food and Drug Administration (FDA) and the American Dental Association (ADA), a dentist is only allowed to prescribe radiographs to the patient if there is a compelling reason to perform the radiography [8]. The FDA has provided a set of guidelines that cover the principles of dental radiography and the elimination of unnecessary radiographs and reducing the dose received by patients [4]. However, these guidelines have not yet been widely introduced and used [8]. The introduction of panoramic radiography improved the efficacy of oral examination and also led to a better diagnosis of oral diseases which early diagnosis of oral diseases leads to a better prognosis.

Rushton et.al.in investigating the factors affecting choosing panoramic radiography among British and Wales general dentists showed that surgical plan, facial traumas, periodontal diseases, extensive restorations and first patient referral were the most important determinants of prescribing panoramic radiography [6].

Sima Nikneshan., *et al*. conducted a study to determine the compliance of FDA guidelines with prescribing panoramic radiography in Tehran general dentists in 2010 - 2011. According to the results of the study, panoramic radiographs in cases of concerns about carcinogenic characteristic of the radiation in 3.6%, good hygiene in 2.6% and evaluation of growth and development before six years of age in 37.9% of dentists did not comply with FDA guidelines. Finally, it was concluded that ease of use of panoramic radiography in 55.5% of cases was the reason for prescribing panoramic radiography and availability of panoramic radiography was the reason of prescription in 47.6% of dentists [9].

Molouk Torabi and colleagues conducted a study in 2013 to investigate the factors influencing the prescription of panoramic radiographs by general dentists in Kerman and their compliance with FDA regulations. They reported that 89.3% of individuals had prescribed panoramic radiographs to assess growth and development before 6 years of age, and 29% had prescribed panoramic radiographs to assess the anterior region of the jaw which did not comply with FDA guidelines for prescribing panoramic radiography and further monitoring is recommended [10].

The results of a study by Niknishan., *et al*. on 10% (500) of dentists in Tehran (total number of 5000 general dentists in Tehran) showed that 38% of dentists were not aware of the guidelines of non-prescription panoramic radiography in primary decay cases [11].

Clinical education, due to the lack of a regular training program, inadequate knowledge of instructors in clinical and group teaching methods may not have a good outcome. The needs of the learners should be identified to plan a training program and choose proper methods for teaching the science and skills and then developed a proper evaluation system to improve the quality of continuing education programs. Improving the quality and upgrading of educational standards in higher education by all countries, especially the leading countries in higher education, has received considerable attention in the last fifty years [12,13].

Some of studies agreed with these results that the purpose of dental care is to maintain and improve the patient's oral health so as to minimize other health risks. In dentistry, multiple intraoral and extracorporeal radiographs are used as needed [14].

Therefore, due to the lack of information on the reasons of panoramic radiography prescription in Kashan, this study was conducted to investigate the frequency of panoramic radiography prescriptions in general dentists of Kashan city and also to compare its prescription guidelines with the guidelines of radiography published by FDA.

Materials and Methods

The present study was a cross-sectional study conducted in Kashan in 2019. It was registered in the Ethics Committee of Kashan University of Medical Sciences under code IR.KAUMS.MEDNT.REC.1398.031. First, a list of general dentists of the city of Kashan and their workplace was obtained from the Medical Office of the city and 100 dentists were entered in the study by consensus. Then, a questionnaire about the factors affecting the request for panoramic radiographs and personal information was provided by a previously trained dental student who could provide the necessary information to the dentist at the workplace. This questionnaire has been developed based on FDA criteria and it has been used in various studies [9,10]. Its reliability was estimated to be 0.89 using the kappa coefficient [9]. In this study, after the face validity of the instrument was confirmed by two radiology professors of Kashan Dental School, its reliability was measured on a pilot sample of 30 subjects. Its validity has been confirmed by radiology professors.

The sampling method was census and according to a similar study in this field, it was found that the highest rate of panoramic radiography prescribed by FDA criteria was 78.6% [10], which with 95% confidence and 5% accuracy the minimum sample size required was calculated as 250 people. Data collection was done at field.

To analyze the data, first the frequency tables of conformity percentages were obtained according to individual variables of the dentists. Chi-square test was used for univariate correlations. Finally, multiple linear regression was used for multivariate analysis. The level of significance was considered as $P < 0.05$.

Results

The present study is a cross-sectional study which was performed to determine the compliance of panoramic radiography prescription with FDA guidelines among general dentists in Kashan in 2019. In this study, 100 people were entered in the study, 7 of whom did not participate in the study and 93 of them completed the study. Of these, 33 (35.5%) were female and the rest were male. The mean age of the subjects was 25.5 to 57 years with a mean age of 41.5 to 9.2 years. Past years of graduation ranged from 1 to 32 years with a mean and standard deviation of 16.1 ± 8.9 years and also the number of dentists attending retraining courses ranged from 0 to 70 times with a mean and standard deviation of 29.3 ± 18.7.

According to the results, the most frequent factors that strongly influenced the prescription of panoramic radiographs were "before and after orthodontic treatment" with 69.9% and "before removable prosthesis" with 63.4% and the most frequent factor that strongly prevented panoramic radiography prescription was "pregnant patients" with 48.4%.

Table 1 shows that the highest percentage of non-compliance of panoramic radiographic prescriptions with FDA criteria were related to "assessment of growth and development before the age of 6 years" with 91.4%, "pregnant patient" with 83.9%, and "determination of height of the alveolar crest in the posterior" with 82.8%, respectively. The highest frequency of compliance with FDA criteria was related to "evolutionary anomalies" with 96.8%, "before and after orthodontic treatments" with 95.7% and "before removable denture" with 94.6%.

As can be seen in table 2, the panoramic radiography prescription variable used for assessing the growth and development before 6 years of age in 100% of dentists age 44 years and younger does not comply with FDA guidelines. However, in dentists aged 45 years and

Order	Items		Status		
			Incompatible	Compatible	
		Frequency	Percentage	Frequency	Percentage
1	The first dentist appointment	73	78.5	20	21.5
2	Evaluation of primary dental caries	59	63.5	34	36.6
3	Early investigation of periodontal diseases	73	78.5	20	21.5
4	Before and after surgical treatments	8	8.6	85	91.4
5	Before and after orthodontic treatments	4	4.3	89	95.7
6	Before removable denture treatment	5	5.4	88	94.6
7	Assessment of growth and development before 6 years of age	85	91.4	8	8.6
8	Assessment of growth and development after 6 years of age	11	11.8	82	88.2
9	Initial evaluation of maxillary sinuses	12	12.9	81	87.1
10	Determination of the height of the alveolar crest in the anterior	69	74.2	24	25.8
11	Determination of height of the alveolar crest in the posterior	77	82.8	16	17.2
12	Diffuse pains	10	10.8	83	89.2
13	Facial swelling	13	14.0	80	86.0
14	Facial trauma	10	10.8	83	89.2
15	Parastasis	39	41.9	54	58.1
16	Jaw movement restrictions	18	19.4	75	80.6
17	Evolutionary anomalies	3	3.2	90	96.8
18	Ease of use	47	50.5	46	49.5
19	Availability of panoramic radiographic equipment	47	50.5	46	49.5
20	Concern about the ef carcinogenous effects of radiation	48	51.6	45	48.4
21	Fear of radiation in the patient	38	40.9	55	59.1
22	Pregnant patients	78	83.9	15	16.1
23	Patient with good health	50	53.8	43	46.2
24	Patients with poor health	65	69.9	28	30.1
25	Patient Request	48	51.6	45	48.4
26	Concern about getting a radiograph of a patient legally	46	49.5	47	50.5
27	Concern about not having a radiograph in a patient's file legally	49	52.7	44	47.3

Table 1: *Frequency of panoramic radiography prescription compliance with FDA guidelines by cause of panoramic prescription among dentists in Kashan in 2019.*

over, this is 81.4%. In this study, there was a significant relationship between the percentage of conformity of evaluation of growth and development before the age of 6 and the age of dentists (P = 0.001).

There was also a significant relationship between the percentage of compliance with FDA guidelines in prescription of panoramic radiographs and the age of dentists in items 10, 11, and 25 ($p < 0.05$).

Order	Items	44 years old and younger		45 years old and older		P. value
		Compatible	Incompatible	Compatible	Incompatible	
1	The first dentist appointment	10 (20.0)	40 (80.0)	10 (23.3)	33 (76.7)	0.703
2	Evaluation of primary dental caries	15 (30.0)	35 (70.0)	19 (44.2)	24 (55.8)	0.157
3	Early investigation of periodontal diseases	8 (16.0)	42 (84.0)	12 (27.9)	31 (72.1)	0.163
4	Before and after surgical treatments	45 (90.0)	5 (10.0)	40 (93.0)	3 (7.0)	0.604
5	Before and after orthodontic treatments	48 (96.0)	2 (4.0)	41 (95.3)	2 (4.7)	0.877
6	Before removable denture treatment	46 (92.0)	4 (8.0)	42 (97.7)	1 (2.3)	0.226
7	Assessment of growth and development before 6 years of age	0	50 (100)	8 (18.6)	35 (81.4)	0.001
8	Assessment of growth and development after 6 years of age	44 (88.0)	6 (12.0)	38 (88.4)	5 (11.6)	0.956
9	Initial evaluation of maxillary sinuses	46 (92.0)	4 (8.0)	35 (81.4)	8 (18.6)	0.128
10	Determination of the height of the alveolar crest in the anterior	7 (14.0)	43 (86.0)	17 (39.5)	26 (60.5)	0.005
11	Determination of height of the alveolar crest in the posterior	5 (10.0)	45 (90.0)	11 (25.6)	32 (74.4)	0.047
12	Diffuse pains	46 (92.0)	4 (8.0)	37 (86.0)	6 (14.0)	0.355
13	Facial swelling	45 (90.0)	5 (10.0)	35 (81.4)	8 (18.6)	0.233
14	Facial trauma	46 (92.0)	4 (8.0)	37 (86.0)	6 (14.0)	0.355
15	Parastasis	28 (56.0)	22 (44.0)	26 (60.5)	17 (39.5)	0.664
16	Jaw movement restrictions	42 (84.0)	8 (16.0)	33 (76.7)	10 (23.3)	0.377
17	Evolutionary anomalies	48 (96.0)	2 (4.0)	42 (97.7)	1 (2.3)	0.649
18	Ease of use	25 (50.0)	25 (50.0)	21 (48.8)	22 (51.2)	0.911
19	Availability of panoramic radiographic equipment	24 (48.0)	26 (52.0)	22 (51.2)	21 (48.8)	0.761
20	Concern about the ef carcinogenous effects of radiation	27(54.0)	23 (46.0)	18 (41.9)	25 (58.1)	0.243
21	Fear of radiation in the patient	33 (66.0)	17 (34.0)	22 (51.2)	21 (48.8)	0.147
22	Pregnant patients	10 (20.0)	40 (80.0)	5 (11.6)	38 (88.4)	0.274
23	Patient with good health	24 (48.0)	26 (52.0)	19 (44.2)	24 (55.8)	0.713
24	Patients with poor health	12 (24.0)	38 (76.0)	16 (37.2)	27 (62.8)	0.166
25	Patient Request	30(60.0)	20 (40.0)	15 (34.9)	28 (65.1)	0.016
26	Concern about getting a radiograph of a patient legally	25 (50.0)	25 (50.0)	22 (51.2)	21 (48.8)	0.911
27	Concern about not having a radiograph in a patient's file legally	24 (48.0)	26 (52.0)	20 (46.5)	23 (53.5)	0.886

Table 2: *Frequency of panoramic radiography prescription compliance with FDA guidelines by age of dentist, Kashan, 2019.*

In this table, it can be seen that between male and female dentists, female dentists are more in compliance with FDA guidelines in prescription of panoramic radiography (P = 0.028) and in assessing growth and development in before the age of 6 years, men were significantly more in compliance with FDA guidelines than women in prescribing panoramic radiographs (P = 0.028). In other influencing factors in the prescribing of panoramic radiographs by dentists, there was no difference between the two groups of male and female dentists in compliance with FDA guidelines.

Order	Items	Female		Male		P. value
		Compatible	Incompatible	Compatible	Incompatible	
1	The first dentist appointment	10 (30.3)	23 (69.7)	10 (16.7)	50 (83.3)	0.126
2	Evaluation of primary dental caries	8 (24.2)	25 (75.8)	26 (43.3)	34 (56.7)	0.067
3	Early investigation of periodontal diseases	4 (12.1)	29 (87.9)	16 (26.7)	44 (73.3)	0.102
4	Before and after surgical treatments	33 (100)	0	52 (86.7)	8 (13.3)	0.028
5	Before and after orthodontic treatments	33 (100)	0	56 (93.3)	4 (6.7)	0.129
6	Before removable denture treatment	31 (93.9)	2 (6.1)	57 (95.0)	3 (5.0)	0.828
7	Assessment of growth and development before 6 years of age	0	33(100)	8 (13.3)	52 (86.7)	0.028
8	Assessment of growth and development after 6 years of age	29 (87.9)	4 (12.1)	53 (88.3)	7 (11.7)	0.948
9	Initial evaluation of maxillary sinuses	29 (87.9)	4 (12.1)	52 (86.7)	8 (13.3)	0.867
10	Determination of the height of the alveolar crest in the anterior	5 (15.2)	28 (84.8)	19(31.7)	41 (68.3)	0.082
11	Determination of height of the alveolar crest in the posterior	4 (12.1)	29 (87.9)	12 (20.0)	48 (80.0)	0.335
12	Diffuse pains	29 (87.9)	4 (12.1)	54 (90.0)	6 (10.0)	0.752
13	Facial swelling	28 (84.8)	5 (15.2)	52 (86.7)	8 (13.3)	0.809
14	Facial trauma	30 (90.9)	3 (9.1)	53(88.3)	7 (11.7)	0.701
15	Parastasis	16(48.5)	17(51.5)	38 (63.3)	22 (36.7)	0.165
16	Jaw movement restrictions	26 (78.8)	7 (21.2)	49 (81.7)	11 (18.3)	0.737
17	Evolutionary anomalies	32(97.0)	1 (3.0)	58 (96.7)	2 (3.3)	0.937
18	Ease of use	16 (48.5)	17(51.5)	30(50.0)	30 (50.0)	0.889
19	Availability of panoramic radiographic equipment	19 (57.6)	14(42.4)	27 (45.0)	33(55.0)	0.246
20	Concern about the ef carcinogenous effects of radiation	16 (48.5)	17(51.5)	29(48.3)	31(51.7)	0.989
21	Fear of radiation in the patient	21(63.6)	12(36.4)	34(56.7)	26(43.3)	0.513
22	Pregnant patients	6 (18.2)	27(81.8)	9 (15.0)	51 (85.0)	0.690
23	Patient with good health	14 (42.4)	19(57.6)	29 (48.3)	31(51.7)	0.584
24	Patients with poor health	7(21.2)	26(78.8)	21(35.0)	39 (65.0)	0.165
25	Patient Request	19 (57.6)	14(42.4)	26(43.3)	34(56.7)	0.189
26	Concern about getting a radiograph of a patient legally	18(54.5)	15 (45.5)	29(48.3)	31(51.7)	0.566
27	Concern about not having a radiograph in a patient's file legally	18(54.5)	15(45.5)	26(43.3)	34(56.7)	0.386

Table 3: *Frequency of panoramic radiography prescription compliance with FDA guidelines by dentist gender, Kashan 98.*

This table shows that there was a significant difference in the examination of primary dental caries for prescription of panoramic radiography in the office and clinic, so that there was a greater incompatibility with the FDA guidelines in prescription of panoramic radiographs in the clinics (P = 0.023). There was also a significant difference in the evaluation of the growth and development before the age of 6 years for prescription of panoramic radiography in the office and clinic, so that there was a higher incompatibility with the FDA guidelines in prescription of panoramic radiography in the clinic (P = 0.028). In addition, there was a significant difference between panoramic radiography prescribing in the office and clinic for evaluation of growth and development after 6 years of age, so that the clinic was more compatible

Order	Items	Private office		Clinic		P. value
		Compatible	Incompatible	Compatible	Incompatible	
1	The first dentist appointment	15 (25.0)	45 (75.0)	5 (15.2)	28 (84.8)	0.269
2	Evaluation of primary dental caries	27 (45.0)	33 (55.0)	7 (21.2)	26 (78.8)	0.023
3	Early investigation of periodontal diseases	15 (25.0)	45 (75.0)	5 (15.2)	28 (84.8)	0.269
4	Before and after surgical treatments	55 (91.7)	5 (8.3)	30 (90.9)	3 (9.1)	0.901
5	Before and after orthodontic treatments	58 (96.7)	2 (3.3)	31 (93.9)	2 (6.1)	0.535
6	Before removable denture treatment	57 (95.0)	3 (5.0)	31 (93.9)	2 (6.1)	0.828
7	Assessment of growth and development before 6 years of age	8 (13.3)	52 (86.7)	0	33 (100)	0.028
8	Assessment of growth and development after 6 years of age	50 (83.3)	10 (16.7)	32 (97.0)	1 (3.0)	0.05
9	Initial evaluation of maxillary sinuses	51 (85.0)	9 (15.0)	30 (90.9)	3 (9.1)	0.416
10	Determination of the height of the alveolar crest in the anterior	19 (31.7)	41 (68.3)	5 (15.2)	28 (84.8)	0.082
11	Determination of height of the alveolar crest in the posterior	15 (25.0)	45 (75.0)	1 (3.0)	32 (97.0)	0.007
12	Diffuse pains	52 (86.7)	8 (13.3)	31 (93.9)	2 (6.1)	0.279
13	Facial swelling	50 (83.3)	10 (16.7)	30 (90.9)	3 (9.1)	0.313
14	Facial trauma	52 (86.7)	8 (13.3)	31 (93.9)	2 (6.1)	0.279
15	Parastasis	32 (53.3)	28 (46.7)	22 (66.7)	11 (33.3)	0.212
16	Jaw movement restrictions	49 (81.7)	11 (18.3)	26 (78.8)	7 (21.2)	0.737
17	Evolutionary anomalies	59 (98.3)	1 (1.7)	31 (93.9)	2 (6.1)	0.251
18	Ease of use	29 (48.3)	31 (51.7)	17 (51.5)	16 (48.5)	0.769
19	Availability of panoramic radiographic equipment	30 (50.0)	30. (50.0)	16 (48.5)	17 (51.5)	0.889
20	Concern about the ef carcinogenous effects of radiation	26 (43.3)	34 (56.7)	19 (57.6)	14 (42.4)	0.189
21	Fear of radiation in the patient	33 (55.0)	27 (45.0)	22 (66.7)	11 (33.3)	0.273
22	Pregnant patients	9 (15.0)	51 (85.0)	6 (18.2)	27 (81.8)	0.690
23	Patient with good health	28 (46.7)	32 (53.3)	15 (45.5)	18 (54.5)	0.911
24	Patients with poor health	21 (35.0)	39 (65.0)	7 (21.2)	26 (78.8)	0.165
25	Patient Request	28 (46.7)	32 (53.3)	17 (51.5)	16 (48.5)	0.654
26	Concern about getting a radiograph of a patient legally	31 (51.7)	29 (48.3)	16 (48.5)	17 (51.5)	0.769
27	Concern about not having a radiograph in a patient's file legally	29 (48.3)	31 (51.7)	15 (45.5)	18 (54.5)	0.790

Table 4: *Frequency of panoramic radiography prescription compliance with FDA guidelines by dentist workplace, Kashan 2019.*

**Dentists who worked both in the private office and in the clinic were placed in the clinic category. Number: 20.*

with FDA guidelines (P = 0.05).There was also a greater compatibility radiographs with FDA guidelines in the prescription of panoramic radiography for examining the height of the alveolar crest in the posterior in the general dentists working in the office.

As shown in table 4-6, in the initial evaluation of maxillary sinuses in compliance of the panoramic radiographs prescription with FDA guidelines in dentists who 15 years or more passed from their graduation was significantly lower (P = 0.008). Also, in determination of the height of the anterior crest of the alveolar crest, the compliance with FDA guidelines in dentists who 14 or more were passed from their graduation was significantly lower (P = 0.029).

Order	Items	14 years and less		15 years and more		P. value
		Compatible	Incompatible	Compatible	Incompatible	
1	The first dentist appointment	7 (17.1)	34 (82.9)	13 (25.0)	39 (75.0)	0.356
2	Evaluation of primary dental caries	12 (29.3)	29 (70.7)	22 (42.3)	30 (57.7)	0.195
3	Early investigation of periodontal diseases	6 (14.6)	35 (85.4)	14 (26.9)	38 (73.1)	0.152
4	Before and after surgical treatments	37 (90.2)	4 (9.8)	48 (92.3)	4 (7.7)	0.725
5	Before and after orthodontic treatments	40 (97.6)	1 (2.4)	49 (94.2)	3 (5.8)	0.432
6	Before removable denture treatment	40 (97.6)	1 (2.4)	48 (92.3)	4 (7.7)	0.265
7	Assessment of growth and development before 6 years of age	1 (2.4)	40 (97.6)	7 (13.5)	45 (86.5)	0.060
8	Assessment of growth and development after 6 years of age	39 (95.1)	2 (4.9)	43 (82.7)	9 (17.3)	0.065
9	Initial evaluation of maxillary sinuses	40 (97.6)	1 (2.4)	41 (78.8)	11 (21.2)	0.008
10	Determination of the height of the alveolar crest in the anterior	6 (14.6)	35 (85.4)	18 (34.6)	34 (65.4)	0.029
11	Determination of height of the alveolar crest in the posterior	4 (9.8)	37 (90.2)	12 (23.1)	40 (76.9)	0.091
12	Diffuse pains	38 (92.7)	3 (7.3)	45 (86.5)	7 (13.5)	0.342
13	Facial swelling	37 (90.2)	4 (9.8)	43 (82.7)	9 (17.3)	0.297
14	Facial trauma	37 (90.2)	4 (9.8)	46 (88.5)	6 (11.5)	0.783
15	Parastasis	26 (63.4)	15 (36.6)	28 (53.8)	24 (46.2)	0.353
16	Jaw movement restrictions	35 (85.4)	6 (14.6)	40 (76.9)	12 (23.1)	0.306
17	Evolutionary anomalies	39 (95.1)	2 (4.9)	51 (98.1)	1 (1.9)	0.423
18	Ease of use	22 (53.7)	19 (46.3)	24 (46.2)	28 (53.8)	0.472
19	Availability of panoramic radiographic equipment	19 (46.3)	22 (53.7)	27 (51.9)	25 (48.1)	0.593
20	Concern about the ef carcinogenous effects of radiation	20 (48.8)	21 (51.2)	25 (48.1)	27 (51.9)	0.946
21	Fear of radiation in the patient	27 (65.9)	14 (34.1)	28 (53.8)	24 (46.2)	0.242
22	Pregnant patients	6 (14.6)	35 (85.4)	9 (17.3)	43 (82.7)	0.728
23	Patient with good health	21 (51.2)	20 (48.8)	22 (42.3)	30 (57.7)	0.392
24	Patients with poor health	10 (24.4)	31 (75.6)	18 (34.6)	34 (65.4)	0.286
25	Patient Request	21 (51.2)	20 (48.8)	24 (46.2)	28 (53.8)	0.627
26	Concern about getting a radiograph of a patient legally	22 (53.7)	19 (46.3)	25 (48.1)	27 (51.9)	0.593
27	Concern about not having a radiograph in a patient's file legally	20 (48.8)	21 (51.2)	24 (46.2)	28 (53.8)	0.801

Table 5: *Frequency of panoramic radiography prescription compliance with FDA guidelines by the years passed of graduation of the dentist, Kashan 2019.*

It was observed that in determination of the height of the alveolar crest in the anterior, dentists who had participated in retraining courses 31 times and more, there was a significantly greater compatibility with the FDA guidelines for panoramic radiography (P = 0.008). It was also observed that in determination of the height of the alveolar crest in the posterior, dentists who had participated in dental training courses 31 times and more, there was a significantly greater compatibility with the FDA guidelines for panoramic radiography (P = 0.025). In addition, the evolutionary anomalies, dentists who had participated in 31 times or more in dental retraining courses were significantly more compatible with the FDA guidelines about panoramic radiographs (P = 0.047).

Order	Items	20 times and less		21 times and more		P. value
		Compatible	Incompatible	Compatible	Incompatible	
1	The first dentist appointment	7 (17.1)	34 (82.9)	13 (25.0)	39 (75.0)	0.356
2	Evaluation of primary dental caries	13 (31.7)	28 (69.3)	21 (40.4)	31 (59.6)	0.388
3	Early investigation of periodontal diseases	5 (12.2)	36 (87.8)	15 (28.8)	37 (71.2)	0.052
4	Before and after surgical treatments	38 (92.7)	3 (7.3)	47 (90.4)	5 (9.6)	0.695
5	Before and after orthodontic treatments	39 (95.1)	2 (4.9)	50 (96.2)	2 (3.8)	0.808
6	Before removable denture treatment	37 (90.2)	4 (9.8)	51 (98.1)	1 (1.9)	0.096
7	Assessment of growth and development before 6 years of age	2 (4.9)	39 (95.1)	6 (11.5)	46 (88.5)	0.255
8	Assessment of growth and development after 6 years of age	38 (92.7)	3 (7.3)	44 (84.6)	8 (15.4)	0.232
9	Initial evaluation of maxillary sinuses	38 (92.7)	3 (7.3)	43 (82.7)	9 (17.3)	0.154
10	Determination of the height of the alveolar crest in the anterior	5 (12.2)	36 (87.8)	19 (36.5)	33 (63.5)	0.008
11	Determination of height of the alveolar crest in the posterior	3 (7.3)	38992.7)	13 (25.0)	39 (75.0)	0.025
12	Diffuse pains	38 (92.7)	3 (7.30	45 (86.5)	7 (13.5)	0.342
13	Facial swelling	37 (90.2)	4 (9.8)	43 (82.7)	9 (17.3)	0.297
14	Facial trauma	37 (90.2)	4 (9.8)	46 (88.5)	6 (11.5)	0.783
15	Parastasis	25 (61.0)	16 (39.0)	29 (55.8)	23 (44.2)	0.613
16	Jaw movement restrictions	33 (80.5)	8 (19.5)	42 (80.8)	10 (19.2)	0.973
17	Evolutionary anomalies	38 (92.7)	3 (7.3)	52 (100)	0	0.047
18	Ease of use	21 (51.2)	20 (48.8)	25 (48.1)	27 (51.9)	0.763
19	Availability of panoramic radiographic equipment	21 (51.2)	20 (48.8)	25 (48.1)	27 (51.9)	0.763
20	Concern about the ef carcinogenous effects of radiation	23 (56.1)	18 (43.9)	22 (42.3)	30 (57.7)	0.186
21	Fear of radiation in the patient	28 (68.3)	13 (31.7)	27 (51.9)	25 (48.1)	0.111
22	Pregnant patients	6 (14.6)	35 (85.4)	9 (17.3)	43 (82.7)	0.728
23	Patient with good health	18 (43.9)	23 (56.1)	25 (48.1)	27 (51.9)	0.689
24	Patients with poor health	9 (22.0)	32 (78.0)	19 (36.5)	33 (63.5)	0.128
25	Patient Request	23 (56.1)	18 (43.9)	22 (42.3)	30 (57.7)	0.186
26	Concern about getting a radiograph of a patient legally	22 (53.7)	19 (46.3)	25 (48.1)	27 (51.9)	0.593
27	Concern about not having a radiograph in a patient's file legally	19 (46.3)	22 (53.7)	25 (48.1)	27 (51.9)	0.868

Table 6: *Frequency of panoramic radiography prescription compliance with FDA guidelines by number of dentist retraining courses, Kashan, 2019.*

Individual characteristics	Regression coefficient	SD	Value	P. value	Adjusted R-square
Age	1.401	0.259	5.401	.000	0.95
Gender (male)	1.320	2.871	0.460	.647	
Years passed from graduation date	-1.270	0.357	-3.555	-3.555	
Workplace (clinic)	6.451	2.798	2.305	2.305	
Participation in retraining courses (more than 20 times)	5.006	4.003	1.251	1.251	

Table 7: *Linear regression model coefficients of percentage of dentist's compliance with FDA guidelines for prescribing panoramic radiographs based on personal characteristics of dentists in Kashan, 2019.*

Results of multiple linear regression model showed that factors including age, years passed of graduation and type of workplace were effective on the percentage of dentists' compliance with FDA guidelines ($P < 0.05$). This model (linear regression) has high predictive power in evaluating the matching percentage (Adjusted R-square = 0.95).

Discussion and Conclusion

Radiographic prescribing decisions usually have to be based on the individual needs of each patient. Dental records, clinical examinations, age and general condition of the patient play key roles in making this decision. Radiography may be necessary when clinical examinations, age, and patient records are unable to provide sufficient information for diagnosis. Diagnostic radiation is only justified when the dentist can play an effective role in the diagnosis and treatment of the patient by using it. In the mid-1980s, the FDA appointed a board to develop guidelines for radiographic prescribing in dentistry so that dentists around the world would be familiar with the requirements for radiographic prescribing.

In this study, 27 factors related to the prescription and non-prescription of panoramic radiographs were investigated. The results showed that "before and after surgical treatment", "before and after orthodontic treatment", before prosthetic treatment, "facial trauma" and "evolutionary anomalies" had the highest role in prescribing panoramic radiographs and the factors including "pregnancy" and "examining primary dental caries" were the most frequent in non-prescribing panoramic radiographs. According to the results of the analysis, more than 50% of the dentists used panoramic radiography prescription for first dental visit (78.5%), primary dental caries examination (63.4%), initial examination of periodontal diseases (78.5%), evaluation of growth and development before 6 years (91.4%), determination of anterior alveolar crest height (74.2%), determination of posterior alveolar crest height (82%), ease of use (50.5%), availability (50.5%), concern about the effects of carcinogenesis effects of radiation (51.6%), pregnant patients (83.9%), patient with good health (53.8%), patients with poor health (69.9%), patient requests (51.6%), concern about the lack of radiographs in the patient's file (52.7%) who does not comply with the FDA's panoramic radiography guidelines.

In the studies by Junwo (2011) and Rushton., *et al*. (2008), prescribing panoramic radiography was of high diagnostic value in the treatment of patients with swelling [4,10]. In this study, in 79.1% of dentists, swelling was the cause of prescribing panoramic radiography. Since panoramic radiographs are capable of extensive displaying of the lesions, this finding is consistent with the proposed guidelines of prescribing panoramic radiography [16]. 2.2% of general dentists prescribed panoramic radiographs for patients with good dental health. According to FDA guidelines, in people who are in good health, periodic bitewing is the only radiograph required depending on the age range [17]. 50.5% of dentists know jaw movement restriction as a possible prescription for panoramic radiography. Regarding that in the restriction of jaw movement and TMJ examination, panoramic radiography is one of the indications prescribed [16], the preference of dentists for panoramic radiography in our study is consistent with the established guidelines.

In evaluating the compliance of panoramic radiography prescriptions with FDA guidelines by the age of dentists and consistent with our study, Sabri., *et al*. showed that the dentist's age did not correlate significantly with their knowledge of FDA guidelines [18]. Therefore, it seems that as the age of the dentists increases and the distance of dentists from their training courses increases with age, there is not a significant relationship between the age of the dentists and the compliance of radiographic prescriptions with FDA guidelines.

Significant differences were observed in the frequency of compliance of prescribing panoramic radiographs with FDA guidelines by the gender of the dentist. In the study of Javadzadeh., *et al*. the gender of the dentist was not significantly correlated with knowledge of FDA guidelines [19]. Overall, according to this study and other studies, it seems that compliance of prescribing the panoramic radiography with FDA guidelines is not significantly related to the gender of the dentist.

In our study, 38.7% and 47.3% of dentists selected the evaluation of the growth and development process before and after six years of age as a strong factor causing panoramic radiography prescription which according to the FDA guidelines, evaluation of the growth and development process before and after six years of age does not require panoramic radiography [16]. In our study, 2.2% of dentists indicated that panoramic radiographs would be strongly prescribed when the patient requested, and this low percentage also does not comply with FDA guidelines and should not be a factor for prescribing panoramic radiography [16,20].

In evaluation of the compliance of prescribing panoramic radiographs with FDA guidelines by the years passed of the graduation of dentist, and in line with the present study, Bardal., *et al*. showed that general dentists' knowledge of panoramic radiography was average. This awareness was 42.8% in the graduates of the last 5 years, while it was 51% in the new graduates. In the present study, knowledge of dentists with less than 5 years work experience was 59.3% and for dentists with work experience more than 5 years, 47.3% [21]. It seems that the number of years passed of the graduation date was more in compliance with FDA guidelines in cases where the dentist has regularly encountered with it.

In this study, only 3.2% of dentists addressed the availability of panoramic radiography as a cause of prescription that is inconsistent with the FDA's scientific and ethical guidelines [22]. In 57% of dentists poor health of patient had no effect on prescribing panoramic radiography, whereas the use of panoramic radiographs could have a benefit. When there is a need for more than four bitewing radiography in a patient, panoramic radiography is an appropriate choice to reduce the number of examinations [22]. Educating and persuading dentists to use FDA radiography guidelines and methods seems to be effective in improving the patient care system. In this study, in evaluation of maxillary sinuses, 48.4% of dentists prescribed panoramic radiographs. It is useful to have a panoramic view of the maxillary sinus for initial examination, and it is important to consider complementary radiographs for lateral wall expansion and extensive lesions [22].

22.6% and 18.3% of the dentists participating in this study mentioned disseminated and paracentesis pains in prescribing panoramic radiography, respectively. Since these two cases fall into the occult disease group and panoramic radiography is allowed to be prescribed in these situations, further education seems to be needed. In the present study, 48.4% of the dentists considered pregnancy as a factor that strongly impedes the prescription of panoramic radiography.

Overall, this study showed that according to the results of regression analysis, at the first dental appointment, early dental caries, early periodontal disease, evaluation of growth and development before 6 years of age, determination of the alveolar crest height in anterior, determination of the alveolar crest height in posterior, ease of use, availability, concerns about the effects of carcinogenesis effects of radiation, pregnancy, patients with good health, patients with poor health, patient request, concerns of not having a radiograph in the patient's file because of legal reasons, more than about 50% of dentists prescribe panoramic radiographs which does not comply with the FDA guidelines.

Therefore, it can be said that the prescription of panoramic radiographs in general dentists in Kashan in some cases does not comply with the FDA guidelines for prescribing panoramic radiographs and therefore more supervision is needed.

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