

Original Research Article

Children's Dental Radiography Experiences and Parental Knowledge and Awareness on Radiation

Çocuklardaki Diş Röntgeni Deneyimleri ve Ebeveynlerin Radyasyon Hakkındaki Bilgi ve Farkındalıkları

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ABSTRACT

Aim: This study aimed to evaluate the past and present radiographic experiences of children, as well as their parents' knowledge and awareness about radiation and radiation protection.

Materials and Method: The parents whose children were ordered dental X-rays at a university hospital participated in the study. A questionnaire was administered regarding the past and present radiologic experiences of their children, the use of protective measures during irradiation, their knowledge about the harmful effects of radiation and the protection. The chi-square test was used to statistically analyze the results.

Results: One hundred and sixty-two parents participated. The patients' average age was 8.91±2.69 years and 55.6% were girl. Only 10.5% of the children did not have any past radiography experience. The 11-14 age group had the highest past experience of radiographs (p=0.003). Protective coverings were used during the past X-ray experiences in ten (8.1%) children. Dental radiographs, predominantly periapical, were repeated in 19 children (11.7%). Of the parents, 25.9% and 6.8% stated that they had sufficient knowledge about the harmful effects of radiation and radiation protection, respectively.

Conclusion: The present study revealed a need to tackle with the inadequateness regarding radiation safety and protection.

Keywords: Awareness; Children; Dental radiography; Knowledge; Parents; Protection; Radiation

ÖZET

Amaç: Bu çalışmada çocukların geçmişe ve şimdiye ait radyografi deneyimleri ile ebeveynlerinin radyasyon ve radyasyondan korunma konusundaki bilgi ve farkındalıklarının değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Çalışmaya, bir üniversite hastanesinde çocuklarına diş röntgeni çekilmesi gereken ebeveynler katılmıştır. Ebeveynlere, çocuklarının geçmişteki ve şimdiki radyolojik deneyimleri, ışınlama sırasında koruyucu önlemlerin kullanımı, radyasyonun zararlı etkileri ve korunma konusundaki bilgileri ile ilgili soruları içeren bir anket uygulanmıştır. Sonuçları istatistiksel olarak analiz etmek için ki-kare testi kullanılmıştır.

Bulgular: Çalışmaya 162 veli katılmıştır. Hastaların ortalama yaşı 8.91±2.69'dur ve %55.6'sı kızdır. Çocukların sadece %10.5'inin daha önce radyografi deneyimi olmadığı öğrenilmiştir. 11-14 yaş grubu en yüksek geçmiş radyografi deneyimine sahiptir (p=0.003). Geçmiş radyografi çekimlerinde, on (%8.1) çocukta koruyucu önlemler kullanıldığı öğrenilmiştir. Ağırlıklı olarak periapikal diş radyografileri 19 çocukta (%11.7) tekrarlanmıştır. Ebeveynlerin %25.9'u radyasyonun zararlı etkileri ve %6.8'i radyasyondan korunma hakkında yeterli bilgiye sahip olduğunu belirtmiştir.

Sonuç: Bu çalışma, radyasyon güvenliği ve korunması konusundaki yetersizliklerin giderilmesi gerektiğini ortaya koymuştur.

Anahtar Kelimeler: Bilgi; Çocuk; Diş röntgeni; Ebeveyn; Farkındalık; Korunma; Radyasyon

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INTRODUCTION

Radiographic imaging is widely used in dentistry for the diagnosis and treatment planning of oral and maxillofacial diseases. The proper use of radiographical techniques rescues lives and enhances patient care.¹ The radiation doses of intraoral or extraoral radiography procedures used in dentistry are comparatively lower than most other medical imaging procedures performed using ionizing radiation to patients. However, there is still a risk of developing stochastic effects due to these imaging procedures. Biologic side effects of radiation may vary depending on the dose and exposure time.² Young patients are more sensitive to ionizing radiation than the adults and in addition to the accumulative effect of ionizing radiation, the increased radiosensitivity of growing tissue and organs in children puts them higher risk.^{3,4}

“As low as reasonably diagnostically acceptable being Indication-oriented and Patient-specific” (ALADA-IP) principle is vital in the practice of dentists for minimizing the exposure of patients to ionizing radiation.⁵ Providing the safety of patients and health workers, lowering the risks related to the use of radiation, maximizing benefits for patients' care is the ultimate goals of radiation protection in health care. The best strategy to reduce the unnecessary radiation risks of pediatric patients is to minimize the dose.⁶ Although the low-level radiation dose is used in pediatric diagnostic imaging, the risks regarding multiple exposures and hence cumulative doses are uncertain.³

Amongst the organs of the head and neck, the thyroid gland is highly sensitive to radiation carcinogenesis.³ Exposure to high-levels of ionizing radiation is one of the known environmental causes of thyroid cancer.³ The anatomic location and the relatively higher radiosensitivity of the gland raises a concern in relation to protecting the thyroid while taking dental radiography.⁴ Using a collar for thyroid during intraoral exposures, and a lead apron for reproductive organs during intraoral and extraoral exposures is recommended for protecting the patients from scattered radiation. Although thyroid collar and lead apron are strongly advised for radiation protection, a recent study showed that dentists were not following these measures especially for patients under 20 years old.⁷

Another point of concern related to radiation protection is eliminating the unnecessary radiologic examinations and exposures. Ordering new radiographs based on accurate clinical indications and questioning about past radiographs⁶ could help lowering the radiation exposure. Radiological imaging which were previously obtained in other health institutions should be accessible by the healthcare providers in other centers to avoid secondary radiation exposure of the same region in patients.⁸ Besides, physicians should encourage patients to explain the imaging examinations they have undergone previously that will impede duplicate images. Tracking radiation exposure by some methods such as radiation cards similar to immunization cards, electronic records by software, or smart cards are among other recommendations.⁸

The present study aimed to evaluate the past and present radiographic experiences of the children admitted to a university hospital, and their parents' knowledge regarding radiation and radiation protection using a face-to-face questionnaire. Although not primary focus of this study, the parents' expectations from the dentists before dental X-ray ordering were also recorded.

MATERIALS AND METHOD

The present descriptive cross-sectional study was conducted at the Department of Pediatric Dentistry at Hacettepe University Faculty of Dentistry between June and September of 2021. Its protocol and the consent form were approved by the Non-Interventional Clinical Research Ethics Board of Hacettepe University (2020- GO 20/748). An anonymous questionnaire form was developed based on the questions used in previous studies.^{7,9,10} The first draft was pre-tested with a group of 35 parents regarding the content and intelligibility. According to the parents' feedbacks, some of the questions were edited and restructured.

The questionnaire, which took 5-7 minutes to complete, included a total of 21 questions. First section consisted of questions about the sociodemographic information of the children and their parents, including age, gender and parents' educational levels, as well as the presence of any chronic disease in the children. The second section inquired about children's previous and present radiography experienc-

es, the presence of repeated radiographs and protective covering during imaging; parental knowledge and awareness about radiation, radiation protection; and parental expectations from the dentist before ordering a dental X-ray.

The study population consisted of parents (n=162) of the children aged 3-14 years whose dental radiographs were ordered following clinical examinations made by the pediatric dentists, excluding the researchers. The parents of patients with mental problems were not included. After the radiographs were taken at the Department of Oral and Maxillofacial Radiology of the same hospital, the parents who were present while the referrer was examining their children, were invited to participate. After obtaining a written consent and explaining that the participation was voluntary, confidential and anonymous, the parents were interviewed, and the answers were recorded.

Statistical analysis was conducted using SPSS for Windows 21.0 (IBM Corp., Armonk, NY). Number, percentage, mean, standard deviation, median, minimum, and maximum values were estimated for descriptive statistics. Chi-square test was used to assess the significance of differences between categorical variables. The significance level was considered as 0.05 in all analyses.

RESULTS

One hundred and sixty-two parents participated in the study, consisting of 75.9% mothers and 24.1% fathers, with a mean age of 38.11 (±6.20). The over-

Table 1. General characteristics of children in the study.

Characteristics	n	%	
Age Groups*	3-6	36	22.2
	7-10	77	47.5
	11-14	49	30.2
Sex	Female	90	55.6
	Male	72	44.4
Systemic Disease	No	141	87.0
	Yes	21	13.0

*X±SD=8.91±2.69; Median=9.0; 1.-3. Quartiles=7.0-11.0; Min-Max=3.0-14.0

all response rate was 88.8%. The data regarding the pre-testing of the questionnaire was not included in the analysis. The mean age of the children was 8.91 (±2.69). Among them 55.6% were female and 13.0% (n=21) had systemic diseases (Table 1). Four children had history for thyroid disorders. One of them was diagnosed with hypothyroidism, and other three children had hyperthyroidism. In two children, history of lymphoma was noted.

Only 10.5% of the children were reported to have no past radiography experience. The ages of children were grouped as 3-6-, 7-10-, and 11-14-year. It was observed that the radiography experience raised as the age groups got older. Past radiography experience was statistically highest among the 11-14-year age group (p=0.003, Table 2). The types of radiography (classified as dental, extra-dental and both) were also analyzed according to the age groups. The statistical significance was present in the 11-

Table 2. Participants' previous radiography experiences according to age groups

Previous X-ray(s) (n=160)*	3-6		7-10		11-14		Total	p**
	n	%	n	%	n	%		
No	8	22.2	9	11.8	0	-	17	
Yes	28	77.8	67	88.2	48	100.0	143	0.003
Total	36	100.0	76	100.0	48	100.0	160	
Only dental	12	33.3	31	40.8	12	25.0	55	
Only extra-dental	7	19.4	9	11.8	4	8.3	20	
Dental & extra-dental	9	25.0	27	35.5	32	66.7	68	0.000

*Two participants whose parent/guardian did not remember whether the child had any previous radiograph(s) taken were excluded from the analysis. **Chi-square test, p<0.05 Statistically significant p-values are shown in bold.

14-year age group which had the highest past dental and extra-dental (non-dental) X-ray experience ($p<0.001$, Table 2). Of the parents, 84.6% ($n=104$) reported that no protective covering (lead apron/thyroid collar) was used for their children during past dental X-ray procedures (Table 3). Only 17 (13.8%) parents stated that they were keeping a copy of the past dental radiographs (Table 3).

During the current visit, 67.3% of the parents reported that they were informed by the pediatric dentist about the reason for ordering the radiograph(s). More than half of the parents (59.3%) were not asked about any previous radiograph(s). In 19 children (11.7%) the radiographs were repeated, and 15 of them were periapical radiographs. The parents of all those children reported that the reason for repeating the dental X-ray was explained to them (Table 3).

Table 3. Parents' answers to some of the questions regarding their children's dental radiography experiences

Questions	n	%
Previous radiography experience (n=162)		
No	17	10.5
Do not remember	2	1.2
Yes, only dental X-rays	55	34.0
Yes, only extra-dental X-rays	20	12.3
Yes, dental and extra-dental X-rays	68	42.0
A protective covering was used during previous dental X-ray taking(s) (n=123)		
Do not remember	8	6.5
No idea since the parents did not see the child during radiograph	1	0.8
Yes, had protective equipment	10	8.1
No protective equipment	104	84.6
Did/do you keep a copy of the previous dental x-ray(s)? (n=123)		
Do not remember	1	0.8
Yes	17	13.8
No	105	85.4
The dentist explained the reason before ordering new X-ray(s) during this visit. (n=162)		
No	48	29.6
Yes	109	67.3
Not sure	5	3.1
The dentist asked about previously taken dental X-ray(s) during this visit. (n=162)		
No	96	59.3
Yes	60	37.0
Not sure	6	3.7
X-rays were retaken during this visit. (n=162)		
No	143	88.3
Yes	19	11.7
The type of retaken dental X-ray during this visit (n=19)		
Periapical	15	9.2
Panoramic	4	2.5
Not sure	-	-
The reason for retaking the X-ray(s) was clearly explained		
Yes	19	100.0
No	-	-
Not sure	-	-

Table 4. Parents’ answers to the questions regarding dental X-rays, and their expectations from the dentist

Parents’ knowledge of radiation and parental expectations	n	%
Parents’ knowledge about the harmful effects of radiation		
Yes	42	25.9
No	95	58.6
Not sure	25	15.4
Parents’ knowledge about radiation protection		
Yes	11	6.8
No	127	78.4
Not sure	24	14.8
Parents’ knowledge about tissues/organs that are mostly affected by dental X-ray taking		
No idea	98	60.5
Have some idea	64	39.5
Brain*	46	71.9
Lungs*	10	15.6
Eyes*	9	14.1
Thyroid*	4	6.2
Heart*	2	3.1
Other (visceral organs, kidney, lymph nodes, pineal gland)*	5	7.8
Parents’ expectations from the dentist before ordering dental X-ray(s) for their children**		
Wants to be informed about:	126	77.8
The reason of ordering	91	56.2
The adverse effects of radiation	71	43.8
The radiation dose	55	34.0
Not sure	36	22.2

* There is more than one answer, the percentages were calculated over the total of parents who claimed that they have some idea (n=64).

**There is more than one answer, the percentages were calculated over the total.

Table 5. Distribution of some knowledge questions by level of education

Knowledge (n=162)	Level of Education						p**
	≤ Secondary school		High School		≥ University		
	n*	%	n*	%	n*	%	
Harmful effects of radiation							
Knows	11	18.0	16	30.8	15	30.6	0.223
Does not know	43	70.5	27	51.9	25	51.0	
Not sure	7	11.5	9	17.3	9	18.4	
Total	61	37.7	52	32.1	49	30.2	
Radiation protection							
Knows	3 _a	4.9	12 _b	23.1	12 _b	24.5	0.027
Does not know	50 _a	82.0	32 _b	61.5	29 _b	59.2	
Not sure	8 _a	13.1	8 _a	15.4	8 _a	16.3	
Total	61	100	52	100	49	100	

* Column percentage

**Chi-square test Statistically significant p-values are shown in bold.

With respect to the knowledge of parents on radiation, 25.9% reported that they had sufficient knowledge about the harmful effects of radiation. Only 6.8% of the parents stated that they had sufficient knowledge about radiation protection. Sixty-four parents (39.5%) asserted that they had some idea about organ(s) which might be most affected by the radiation from dental X-rays. The most reported organs were the brain (n=46), lungs (n=10), eyes (n=9), and the thyroid (n=4) (Table 4). As for the expectations of parents from dentists before ordering a dental X-ray, more than half of them stated that they would like to be informed about the reason (Table 4).

Given that the parental knowledge regarding harmful effects of radiation by education levels of parents, the number of parents that graduated from secondary/primary school was higher among those who reported that they did not have sufficient knowledge although not statistically significant (Table 5, $p=0.223$). Besides, the number of parents who stated that they did not have sufficient knowledge about radiation protection were statistically higher among primary/secondary school graduates (Table 5, $p=0.027$).

DISCUSSION

Dental radiography adds valuable information to the dental examination and contribute significantly to the diagnosis and treatment of pathological conditions, developmental problems, or dental injuries. However, the risks associated with the use of radiation should also be kept in mind.¹¹ Informing the patients about the need for ordering as well as the risks and benefits of radiographs and protecting them from radiation during these procedures have been particularly emphasized in the literature.^{6,9}

There is still limited data about parents' knowledge and expectations regarding radiography for children.^{9,10} The questionnaire is a well-established tool to obtain information about the demographic and social characteristics, current and past behaviors, habits, knowledge, behavioral standards or attitudes of the participants in relation to any subject under investigation. Although conducting a survey using internet is an easier and time-saving way, people can be reluctant to respond to online questionnaires as shown by the lower response rates in previous studies.^{12,13} Likewise, the respond rate can also be

low in paper surveys.¹⁰ The present study utilized face-to-face interview method. This lead to an overall response rate of 88.8%, which was higher than those obtained in other studies.^{12,13}

The European Commission has reported that the number of dental X-rays were about one-third of all X-ray examinations.¹⁴ In the present study, the percentages of children with past radiographic experience for any part of the body and dental X-ray was 89 and 77, respectively. In a study by Oikarinen *et al.*,⁹ children with past radiographic experience were reported as 73% (any part of the body), while Chiri *et al.*¹⁰ reported a rate of 61% for children who had past dental X-ray experience. In the present study, it was also found that the number of past radiographs increased in line with the age of children. The past radiography experience was significantly high in the 11-14-year age group. Young *et al.*¹⁵ compared past dental radiography experiences of children between 3 and 14 years of age and reported that past radiographs of children who needed permanent teeth extractions were significantly higher (46.2%) than children in primary dentition who needed primary tooth extractions (6.3%). They assumed that few dentists routinely use radiographs for caries diagnosis of children, particularly in primary dentition since they are unable to tolerate intra-oral radiographs.

The ordering of dental radiographs should be justified by the practitioner before exposing a child to ionizing radiation.⁹ Additionally, the child and the parents should be properly informed about the reasoning of any new radiographs.^{6,9} Oikarinen *et al.*⁹ evaluated the parents' experiences and expectations regarding the information obtained from the referrer. In their study, out of 41, 34 parents (83%) told that they received adequate information on the purpose of the radiographic examination. Thirty-eight of 40 parents expected information about the reason, while 35 and 31 parents wished to be informed on radiation dose and alternative methods to radiography, respectively.⁹ Shah *et al.*¹⁶ reported that only about 40% of parents had been informed by the dentist about the reasons for taking dental x-rays and the risks involved. Sreenivasan *et al.*¹⁷ reported that half of the parents did not ask for an explanation regarding the need for the dental radiograph for their children. Majority of Turkish parents (85%) were reported to have a need for information on the benefits and risks of pediatric

dental X-rays and on radiation protection measures for children.¹⁸ In the present study, 67.3% of the parents stated that they were informed about the reason for the radiographs ordered. Similar to the study of Kose *et al.*,¹⁸ a vast majority of them (77.8%) expected to be informed, especially about the reason, dose, and the possible harmful effects of dental radiographs. Both the numbers of parents who were informed and parents who were expecting information were less than those reported by Oikarinen *et al.*⁹ The difference may be related to sociocultural levels of participants, and radiation legislation of that country (Radiation act 9.11.2018/859) which contains a section about provision of information and requesting consent for the imaging. Furthermore, a high percentage of parents (90%) were reported to be explained about the need for dental X-rays by dentists in study of Chiri *et al.*¹⁰ Legislations and regulations to enforce requesting consent that is in compliance with health and safety standards may be developed across the world.

The benefits of appropriate radiographic examination are well established.¹⁹ However, measuring benefit quantitatively, and assessing risks vs benefits seems difficult in health systems.⁶ In the present health system of Turkey, a health application "E-Pulse" has been recently developed for the use of health professionals in the country. The hospitals should integrate into the system of telemedicine and the monitoring system set by the Ministry of Health so that their radiological images can be accessible through the E-pulse system and accessible by other healthcare providers. Parents who seek dental treatment for their children may prefer public and private providers within short intervals and, therefore, children may have radiographs in various places. Since integration to the telemedicine and monitoring system is not obligatory (like the hospital in this study was not integrated to this system during the research period), the number of repeated radiographs and radiation exposure of children could increase. Implementing integration in all institutions and private practices where radiographs are taken could reduce the risk of repeated radiographic exposure. In this study, while 77% of the children had a previous dental radiograph, only 13.8% of the parents were keeping a copy of the past radiograph. This may reflect the lack of parental knowledge and awareness

regarding repeated radiographs. The percentages of parents who reported that no protective covering was worn by their children during past dental radiographs were 85. The present study showed that both questioning dental history regarding previous X-rays and the usage of protective covering were insufficient.

The parents who stated that they did not have sufficient knowledge about radiation protection was significantly higher among those who graduated from secondary/primary school. Sin *et al.*²⁰ reported a significant relationship between people's education level and the knowledge of radiation protection. Similarly, in recent studies, parental knowledge and awareness of dental radiography of children was reported to be higher with increasing levels of education.^{18,21} In the present study, only 25.9% parents knew the harmful effects of X-ray radiation and 6.8% were aware of radiation protection. The families' knowledge and awareness about radiation protection was found to be exceptionally low and should be developed.

According to the study by Benn *et al.*²² dentists were possibly leading to about 967 new cancer cases annually in the head and neck region, mostly due to intraoral radiographs and CBCT. To reduce the number of radiographs, using an informed consent form with sufficient information were recommended to help patients and dentists for realizing the associated risks. The responsibility of the health personnel which is "First, Do No Harm" and sensitivity of especially children to radiation should be kept in mind.²²

The rate of repeated radiographs ranges between 3 and 15% in the literature.²³ This rate may be used as a work quality measure since it relates to reducing patients' exposure to radiation, limiting film usage and time.²⁴ In the present study, periapical and panoramic radiographs were repeated with the percentages of 9.2 and 2.5, respectively. Acharya *et al.*,²⁵ defined the repeat rate as the proportion of rejected radiographs to the total radiographs. They reported a repeat rate of 13% for intra and extraoral radiographs, which was similar to the overall repeat percentage (11.7%) of the present study. However, their rate for intraoral radiographs was lower (7.1%), while the rate for extraoral radiographs was higher (5.9%). The repeat rate for intraoral radiographs

represents the proportion of patients with repeated radiographs in the present study. Hence, it would be lower if the calculation was conducted on total radiographs instead of patients. In the study of Acharya *et al.*,²⁵ radiographs were also taken by undergraduate students and interns who have the highest repeat rate compared to staff and radiographers. In the present study, only radiography technicians were in charge of radiographs. Lin *et al.*,²⁶ studied on the association between annual mean X-ray frequency and benign brain tumors (BBT). They indicated that BBT risk increased with dental exposure which implied the risk of repeated/multiple dental radiography exposure. According to quality control recommendations for diagnostic radiographs, which were prepared by the Conference of Radiation Control Program Directors (CRCPD), repeated analysis must be done quarterly to minimize patient exposure and to assure a standard quality for dental facilities.²⁷ The committee on quality assurance in diagnostic X-ray recommended a repeat rate lower than 5-7%.²⁷ The repeat rate analysis can also help the facilities to be aware of their needs, such as equipment problems and re-calibration.

The thyroid gland is the most radiosensitive organ to dental imaging, especially in young patients. It is the possible environmental risk factor for thyroid cancer.^{4,19,28} In the present study, 46 parents stated that the brain was the most affected organ, while only four parents indicated the thyroid gland. No previous studies have been reported on parental knowledge about radiosensitive organs in dental imaging. However, in the study of Ng *et al.*,²⁹ only 41.9% of parents agreed that exposure to ionizing radiation might have increased the risk of cancer, indicating the inadequate parental awareness of medical radiation exposure. Likewise, another study reported that a significant number of parents (%63) showed a lack of knowledge about the harmful effects of dental radiography in children compared to adults.¹⁷ Besides, most parents (%64) were unaware of the availability of a protective cover during radiation exposure and very few requested for a protective equipment. According to the report by The American Thyroid Association,³⁰ thyroid protection should be used for all dental X-rays since it would not interfere with the radiographical examination.

The present study should be interpreted in light of several limitations. First, findings were obtained via a self-report methodology, which may have prejudices due to the memory factor. Second, the results cannot be generalized for the entire population since it was a non-representative descriptive study. Therefore, studies employing larger samples with more representative hospitals including public and private healthcare providers are warranted. Besides, further studies could be conducted to investigate why practitioners do not always implement protective coverings, despite their training on the importance of radiation protection.

CONCLUSIONS

The present study indicated that both past and current radiographic experiences were lacking adequate radiation protection for the pediatric patients. Parental knowledge of radiation and radiation protection is also not sufficient. The use of protective coverings during dental radiographic procedures in children should be kept in mind. In order to prevent unnecessary exposures, the dentists should question the previous radiographs.

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