ORIGINAL ARTICLE

UDC: 376:616.31-051]:616.314-053.2-073
DOI: https://doi.org/10.2298/VSP191122147M

Evaluation of dentists' knowledge about the use of radiology in pediatric dentistry in Serbia

Procena znanja doktora stomatologije u Srbiji o primeni rendgenologije u dečjoj stomatologiji

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Abstract

Background/Aim. Radiology is a crucial part of dentists' everyday practice. It plays a vital role in diagnosis, treatment planning and the follow-up care of patients. The aim of this study was to evaluate the knowledge of dentists in Serbia concerning the use of radiology in pediatric dentistry. **Methods.** In total, 252 dentists from across Serbia participated in the study. A questionnaire was created in order to examine dentists' knowledge about the use of radiology in pediatric dentistry. The questionnaire consisted of 39 questions. All questions were analyzed in SPSS 24 statistical software. **Results.** According to the results, 42.1% of dentists worked in private practice, 17.8% at University clinics and 40.1% in National Health Services. Out of total 252 respondents, only 82 (32.5%) had an x-ray unit. A total of 199 (79%) dentists replied they would diagnose early caries lesions only by inspection, but 30 (11.9%) dentists said they would make a diagnosis by doing both the inspection and taking a radiograph. The results show that 187 (74.2%) respondents said that they did not make an OPG for every patient. When asked about the disposal of radiological waste, 84.3% of dentists did not answer the question. **Conclusion.** Attempts should be made in order to upgrade and update Serbian dentists overall knowledge about the use of radiology in pediatric dentistry.

Key words:
dentists; knowledge; dentistry, pediatric; radiography; surveys and questionnaires; serbia.

Apstrakt

Uvod/Cilj. Rendgenologija predstavlja važan deo stomatološke prakse. Njena primena je veoma značajna u dijagnozi, planiranju i kasnijem praćenju zdravstvenog stanja pacijenta. Cilj istraživanja bio je da se proceni znanje i stavovi doktora stomatologije u Srbiji o primeni rendgenologije u dečjoj stomatologiji. **Metode.** U studiji su učestvovala 252 stomatologa iz Republike Srbije. Konstruisan je upitnik za ispitivanje stavova stomatologa o primeni rendgenologije u dečjoj stomatologiji. Upitnik se sastojao od 39 pitanja. Sva pitanja su obrađena u SPSS 24 statističkom program. **Rezultati.** Na osnovu dobijenih rezultata, 42,1% stomatologa radilo je u privatnoj praksi, 17,8% na univerzitetskim klinikama i 40,1% u domovima zdravlja. Ukupno, 199 (79%) stomatologa odgovorilo je da bi ranu karijesnu leziju dijagnostikovali samo inspekcijom, dok je 30 (11,9%) stomatologa odgovorilo da bi postavili dijagnozu na osnovu inspekcije i radiografisanja. Od ukupno 252 ispitanika, samo 82 (32,5%) imalo je rendgen aparat. Ukupno 187 (74,2%) ispitanika odgovorilo je da ne prave ortopantomografski snimak za svakog pacijenta. Na pitanje o odlaganju radiografskog otpada, 84,3% stomatologa nije imalo odgovor. **Zaključak.** Postoji potreba da se znanja stomatologa u Srbiji o primeni rendgenologije u dečjoj stomatologiji nadogradi i unapredi.

Ključne reči:
stomatolozi; znanje; stomatologija, dečija; radiografija; ankete i upitnici; srbija.

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Introduction

The discovery of x-rays changed the medical world. Dentistry was no less affected by this finding. The use of x-rays in pediatric dentistry is not only vital for the diagnosis of a disease and treatment planning, but also for the follow-up care of patients. The negative side of using x-rays is the inevitable exposure to radiation, of both patients and medical staff. This downside cannot be eliminated, but using adequate protective equipment and defining indications for the use of radiographs, exposure to radiation can be reduced significantly [1].

The radiation dose should be kept as low as it can reasonably be achieved both for a patient and an operator. The younger the individual, the higher the vulnerability to radiation is because of the large number of cell divisions occurring in small children [2].

Protective equipment such as lead aprons, protective thyroid collar and radiation protective shields are one of the basic ways to prevent high exposure to x-rays. Evidence shows that this protective equipment is efficient in reducing unnecessary x-ray radiation [3].

Having in mind the side effects of x-rays, every radiograph has to be justified. The most effective way to reduce the radiation dose in dental radiography is to avoid unnecessary x-ray examinations [1]. Knowing how important radiology is in dental medicine, avoiding x-ray examination altogether is impossible. This is why establishing guidelines for intraoral and extraoral radiography is a top priority. Indications for pediatric dental radiography are numerous, but most commonly they include diagnostics of dental caries, periapical dental disease, dental trauma, development abnormalities, periodontal disease and many more [4].

Methods

In total, 252 dentists from across Serbia participated in the study. A questionnaire was created in order to examine dentists' knowledge towards radiology in pediatric dentistry. The questionnaire consists of 39 questions (Table 1). There were five segments in which all questions were divided: demographic

Table 1

Questionnaire

1. How old are you? _____
2. How long have you been practicing dentistry? _____
3. Title: a) General practitioner; b) Dental specialist; c) Assistant professor; d) Professor
4. Workplace: a) Private practice; b) University clinic; c) National Health Service
5. The city and district of workplace: _____
6. Approximately, how many periapical radiographs are taken at your clinic every week? a) 0-10; b) 11-20; c) 21 and more
7. Do you take an orthopantomograph (OPG) for every patient? a) Yes; b) No
8. Do you use a negatoscope while analyzing radiographs? a) Yes; b) No
9. The risk of excessive x-ray exposure is efficiently reduced by: a) Protective equipment; b) Establishing adequate indications; c) Reducing the exposure time; d) Collimator is used
10. What method is the most suitable for diagnosing a fractured jaw? a) Cone beam computed tomography (CBCT); b) Computed tomography (CT); c) I do not know
11. What method is the most suitable for diagnosing orthodontic anomalies? a) CBCT; b) OPG
12. Can pregnant women, with the use of protective equipment, be exposed to: a) Intraoral radiography; b) OPG; c) Both; d) I would not make radiographs of pregnant women
13. What are the indications for radiographs in your everyday use? _____
14. When do you use radiology in traumatology? a) Fractures of deciduous teeth; b) Fractures of permanent teeth; c) Both
15. What radiological method is the most suitable for diagnosing an early caries lesion? a) Periapical radiograph; b) Bitewing x-ray
16. Do you use a reduced x-ray field in pediatric dentistry? a) Yes; b) No
17. What are the indications for 3D radiographs in pediatric dentistry? _____
18. How do you measure working length of teeth in children? a) Radiographs; b) Electronic apex locator
19. What method is the most suitable for diagnosing an early caries lesion? a) Inspection; b) Radiography; c) Both
20. Do you have an x-ray unit in your clinic? a) Yes b) No
21. What type of x-ray unit do you have? a) Digital x-ray machine; b) Standard x-ray machine c) Both d) None of the above
22. Age of the x-ray equipment: a) _____b) I do not know
23. The kilovolt (kV) and milliampere (mA) of your x-ray equipment: a) _____b) I do not know
24. The cone type of your x-ray: a) Short cone; b) Long cone; c) Pointed; d) I do not know; e) Two or more
25. Which type of collimator do you use? a) Rectangular; b) Rounded; c) I do not know; d) I do not use one
26. Do you adjust the exposure time according to the location of the tooth where the radiograph will be taken? a) Yes b) No
27. Do you use a film holder while taking radiographs? a) Yes; b) No
28. Do you or your assistant hold the x-ray film with a finger while taking radiographs? a) Yes; b) No
29. Who manages the radiological equipment at your clinic? a) Dentist; b) X-ray technician; c) Nurse
30. Do you use a dosimeter to measure the radiation dose? If you do use it, please indicate the type: a) Yes _____; b) No
31. The brand of a processing solution that you use: a)_____; b) I do not know
32. Do you have a license for your x-ray equipment? a) Yes; b) No
33. Is your x-ray equipment inspected regularly? a) Yes; b) No
34. Do you have an OPG machine at your clinic? a) Yes; b) No
35. How do you dispose your radiological waste? _____
36. Are the walls of the x-ray room covered with lead? a) Yes; b) No
37. Do you have a protective barrier in your practice? a) Yes; b) No
38. Do your patients wear a lead apron while being exposed to x-rays? a) Yes; b) No
39. Do your patients wear a thyroid collar while being exposed to x-rays? a) Yes; b) No

characteristics of dentists, indications for radiography, radiographic equipment, radiographic techniques, and radiation protection.

The statistical analysis was performed in the SPSS 24 statistical software. χ^2-test was used to determine the significance of differences between two independent groups. In the process of examining the relationship between variables ANOVA test was used. The level of significance was set at 5% ($p < 0.05$).

Results

Profile of respondents

The average age of pediatric dentists who participated in the study was 40.6 ± 9 years (range 23–65 years). The average duration of their practice was 14 ± 8.8 years (range 1–37 years). Out of 252 participants, 208 (82.2%) practiced in primary [private practice and National Health Services (NHS)] and 44 (17.8%) in tertiary health care (University clinics). The data obtained showed that 130 (51.6%) participants defined themselves as general practitioners who work with pediatric patients, 78 (31%) as pediatric dental specialists, 20 (7.9%) as assistant professors and 24 (9.5%) as professors of pediatric dentistry. According to the results, 42.1% dentists worked in private practice, 17.8% at University clinics and 40.1% in NHS.

Indications for radiography

The most commonly mentioned reason for taking radiographs was the diagnosis of dental caries (46.8%). A total of 199 (79%) dentists replied they would diagnose early caries lesions only by inspection, but 30 (11.9%) dentists said they would make a diagnosis by doing both the inspection and taking a radiograph. The results showed that the respondents were divided when choosing a suitable method for diagnosing an early caries lesion with 109 (43.3%) dentists answering periapical and the same number answering bitewing radiographs. The rest of the respondents (13.5%) did not know the answer to this question. A majority of respondents (61.5%) responded that they would take radiographs of both deciduous and permanent teeth in case of dental trauma.

There was a significant difference between the workplace of dentists and method of measuring the working length of teeth in children ($p < 0.000$) during endodontic procedures. Only 2.3% of dentists working in a hospital used radiography as a preferred method of measuring the working length, whereas 42.6% of dentists working in public health care used the same method.

Only 6.3% of the respondents replied they would expose pregnant women to both intraoral radiography and orthopantomography.

Indications for 3D radiographs in pediatric dentistry were various. Dentists working at University clinics (31.2%) reported to use 3D radiographs mostly in orthodontics, whereas the majority of dentists working both in private practice (36.8%) and NHS (32.7%) did not have an answer to this question (Table 2). A large percent of dentists (77%) agreed that they would rather use an orthopantomogram (OPG) rather than cone beam computed tomography (CBCT) for diagnosing orthodontic anomalies. Only 31 (12.3%) dentists replied that they would use computed tomography (CT) instead of CBCT for diagnosing a fractured jaw.

Radiographic equipment

Out of total 252 respondents, only 82 (32.5%) have x-ray units. Dentists who practice at University clinics were better equipped with the results showing 54.6% of them have an x-ray unit. The results showed a significant difference between the dentists' workplace and the use of a panoramic unit ($p < 0.000$). Out of all dentists who practiced at University clinics, 61.4% had an access to a panoramic unit, whereas 80.4% of dentists working in private practice did not have a panoramic unit in their workplace.

All data about digital x-ray units are shown in (Table 3).

Table 2

Indications for 3D radiographs in pediatric dentistry

Indications	Private practice	NHS	University clinic	Total
Endodontics	2.1	12.6	10	7.35
Orthodontics	32.6	20.1	31.2	26.35
Periodontology	0	0	0	0
Oral surgery	18.1	10.7	12.5	14.4
Diagnostics of cavities	0	1.9	0	0.95
Dental trauma	10.4	22	22.5	16.2
No answer	36.8	32.7	23.8	34.75
Total	100	100	100	100

All values are expressed as percentages.
NAS – National Health Service.

Table 3

Type of the x-ray unit

X-ray unit type	Private practice	NHS	University clinic	Total
Digital x-ray	25.2	1.3	52.3	25.4
Standard x-ray	5.6	15.8	2.3	9.1
Both	2.8	13.9	11.4	8.7
None of the above	66.4	56.4	34.1	56.7
Total	100	100	100	100

All values are expressed as percentages.
NHS – National Health Service.

A noticeably large percent of dentists (81%) reported they do not know the age of the x-ray equipment used for radiographs. Similar results were obtained concerning the question about the number of kilovolt and milliampere of the x-ray unit. Only 9 (3.6%) of the dentists knew the answer to this question. Just 76 (30.2%) respondents confirmed having a license for their x-ray equipment.

Different cone types (short cone, long cone, short pointed cone and two or more cones) varied from one institution to another. Long cone was the most preferred cone type among the dentists (9.5%), but a greater number of the dentists responded that they did not know which cone type is used for radiographs (79%).

Only 3 (1.2%) respondents answered having rectangular collimators and 212 (84.1%) reported that they did not know the type of collimator they used. There were 65 (25.8%) dentists who replied that they use a dosimeter to measure the radiation dose. Examining the knowledge of the respondents, results showed that 158 (62.7%) dentists use a negatoscope while analyzing radiographs.

A significant percent of the dentists (94.5%) did not know the type of chemicals they use for their radiographs, and only 2.7% reported that they use automatic processor. The results showed that the majority of the dentists (57.9%) did not answer if they check their x-ray equipment regularly and a smaller percentage (35.7%) check their equipment on a regular basis. When asked about the disposal of radiological waste, 84.3% of the dentists did not answer the question.

Radiographic techniques

The largest amount of periapical radiographs per week are taken at University clinics (34.1%) and NHS (34.2%) with the most common answer of 21 and more taken radiographs per week. The results show that 187 (74.2%) respondents said that they do not make an OPG for every patient. A notably high percent of dentists answered that they use a reduced x-ray field in pediatric dentistry (72.2%), but 18.7% did not have an answer to this question. There were 136 (54%) dentists who did not answer if they set the exposure time according to the location of tooth while taking a periapical radiograph. Only 35.7% of dentists adjust the exposure time depending on the tooth location. As a preferable method, 20 (7.9%) respondents use the method of holding the film with their finger while taking radiographs. The results show that film holders are not in common use among the dentists practicing in Serbia. Only 17.5% of the dentists taking part in the study use a film holder.

According to the results, the percentage of personnel in charge of taking radiographs according to the place of employment showed that 51.4% of pediatric dentists did not know the answer to this question, and the nurses were least common to work with the x-ray equipment (2.8%) (Table 4).

Radiation protection

Interesting results were obtained concerning the use of radiation protective equipment (lead walls of the x-ray room, lead aprons, protective barriers and thyroid collars). There was a statistical difference found between the place of employment and the use of protective equipment ($p < 0.000$). Dentists who worked in private practice mostly answered that they do not know if the walls should be covered with lead (62.6%), whereas the majority of pediatric dentists who worked at University clinics reported positively to this question (63.6%). According to the results, protective barriers are mostly used at University clinic with 70.5% of dentists working at University clinics replying they use protective barriers. Only 28% of pediatric dentists working in private practice had the same answer. There were 102 (40.5%) participants who replied they use thyroid collars regularly and 124 (49.2%) participants did not answer this question. Data about the knowledge regarding the use of lead aprons are shown in Table 5.

Table 4

Personnel in charge of taking radiographs according to the place of employment

Personns	Private practice	NHS	University clinic	Total
Dentist	17	1	6.8	8.8
X-ray technician	15.1	50.5	59.1	37.1
Nurse	3.8	2	2.3	2.8
I do not know	64.2	46.5	31.8	51.4
Total	100	100	100	100

All values are expressed as percentages.
NHS – National Health Service.

Table 5

Use of lead apron according to workplace

Answers	Private practice	NHS	University clinic	Total
Yes	29.9	55.4	65.9	46.4
No	9.4	1	9.1	6
No answer	60.7	43.6	25	47.6
Total	100	100	100	100

All values are expressed as percentages.
NHS – National Health Service.

Discussion

Indications for radiography

The purpose of radiographic examination for dental caries is to examine tooth surfaces at risk, which cannot be readily visualized by direct methods. Periapical or bitewing views may also be used to augment clinical examinations in cases in which the presence or extent of carious involvement is in question. An official report of the American Academy of Oral and Maxillofacial Radiology [5] says the best way to detect dental caries in the posterior quadrants is by bitewing radiographic technique and periapical projections are made for the anterior teeth due to the buccolingual inclination of the teeth. These methods for diagnosing dental caries are commonly used among pediatric dentists in Serbia as well. Though most of them would diagnose dental caries only by oral examination, the rest were divided between periapical and buccolingual radiographs.

The use of x-ray units in dentistry is a complex question when considering pregnant women as patients. One of the studies on this topic says radiographic examination in pregnant women must be performed only in the second trimester in order to reduce the chances of deleterious effects [6]. We found that a majority of pediatric dentists in Serbia would not expose women to any kind of radiography. A research of North Queensland dentists [7] had an opposite result. The most preferred procedural change for pregnant patients was to take only intraoral radiographs if urgent for diagnosis (95.2%). Kelaranta et al.[8] conducted a study of radiation exposure of the fetus and breasts during dental x-ray examinations and the effect of lead shields. The information gathered based on the results of intraoral, panoramic, cephalometric and CBCT dental modalities shows the upper estimates of fetal doses varied from 0.009 to 6.9 μGy without lead shielding and from 0.005 to 2.1 μGy with lead shielding. Most importantly, this study explains that pregnancy is never a reason to avoid or to postpone a clinically justified dental radiographic examination.

CT imaging is the most significant technological advance in maxillofacial imaging since the introduction of panoramic radiography. All CT scanners consist of an x-ray source and a detector mounted on a rotating gantry. Although providing similar images, using CBCT we can adjust exposure factors such as the field size, selected for each patient based on individual needs and therefore reduce the exposure to x-rays [4]. Majority (34.75%) of dentists participating in our study answered that they did not know the indications for the use of CBCT. Second and third highest scored were orthodontics (26.35%) and dental trauma (16.2%). In a Scandinavian study [9], it was determined that the two most common reasons for a CBCT are assessment of an ectopic canine and localization of an impacted second premolar. A study published in 2019 about digital radiography and CBCT [10] states that dental trauma was cited as the reason for using CBCT by 70 (61.3%) subjects, dental development issues by 71% and pathology in the jaws by 75.8%. In our study, CBCT was shown to be the most preferable method for diagnosing jaw fractures. A cross-sectional analysis of the National Hospital Ambulatory Care [11] states that the number of CT neuroimagings among children with head injuries did not decrease from 2007 to 2015. This result is supported by the American Academy of Oral and Maxillofacial Radiology [5], which says that one of the indications for the use of CT is when cases involve bone grafts or complex orofacial trauma.

Radiologic examination is essential for evaluating trauma to the teeth and jaws. Although a panoramic image may be useful for localizing injuries to the teeth and supporting structures, it may not have the image resolution to reveal injuries involving the anterior mandible or maxillae or the teeth. Dentoalveolar trauma always requires intraoral images to obtain adequate anatomic details [4]. This rule is applied by the majority of pediatric dentists in Serbia. The European DIMITRA project (Dentomaxillofacial pediatric imaging: an investigation toward low-dose radiation induced risks) published a review about the use of CBCT in pediatric dentistry, in which it is stated that CBCT is more useful in the diagnostics of periapical pathology arising from traumatic events, in comparison to intraoral radiographs [12].

Radiographic equipment

X-ray units are not a common part of dental practice in Serbia. Only one third of the participants answered having this unit in their workplace and a similar result was obtained when discussing if dentists had routine access to a panoramic unit. A survey of general practitioners in England and Wales [13] says all dentists had access to an intraoral radiographic unit and 61% had routine access to a panoramic unit. The majority of practices within the North Queensland [7] region reported using intraoral radiographic equipment (96.8%) as well.

Digital intraoral receptors require less radiation dose to produce images as compared to conventional films. The results from an Indian study showed 38.7% of dentists used this system while still remaining adherent to analog receptor system [14]. The most preferred x-ray units by Serbian pediatric dentists are digital x-ray units.

In our research, basic knowledge about the age of their x-ray units, cone and collimator types, kilovolts and milliamperes proved to be rather limited, with the prevalence of dentists that did not have answers to these questions. Knowledge, attitudes and practices of North Queensland dentists [7] showed that most radiographic equipment appeared to be greater than 6 years old. In approximately two thirds of the cases (61.3%), the dentists used tube voltage of 65–70 kVp, and half of the responders a tube current of under 10 mA. A total of 73.4% of participants in a study in India [14] were not aware of the type of collimator used in their x-ray equipment. Of all respondents in a research about the use of radiation dose reduction techniques, 50.5% use long cones either exclusively or in combination with short cones [15]. Only one quarter of Serbian dentists who participated in the research answered they used exposure badges, whereas 88.8% of Australian dentists [7] reported wearing exposure badges while in their practice.

To ensure the optimum exposure condition, quality assurance tests of dental x-ray units should be performed. In India, Atomic Energy Regulatory Board (AERB) mandates that quality assurance tests of dental x-ray units should be carried out every two years by certified professionals. Despite this fact, a study has shown only 36.8% of the dentists were aware of this fact [14]. Some researches show that 92.1% of the dentists record periodic services at approximately 12 or 24 months (31%) [6], whereas the largest number of our respondents did not even answer this question.

Radiographic techniques

Panoramic imaging (also called pantomography) is a technique for producing a single image of the facial structures that includes both the maxillary and the mandibular dental arches and their supporting structures. Panoramic images are most useful clinically for diagnostic problems requiring broad coverage of the jaws. Panoramic imaging is often used as the initial evaluation image that can provide the required insight or assist in determining the need for other projections [4]. A notably high percent of pediatric dentists in Serbia answered that they do not make an OPG for every patient, which is similar to the results from a Turkish study [16], which states that only 8.9% of their respondents take panoramic radiographs on patients' first visits.

Intraoral radiographic (imaging) examinations are the backbone of imaging for a general dentist. Intraoral images can be divided into three categories: periapical projections, bitewing projections, and occlusal projections. Periapical radiographs should show all of a tooth, including the surrounding bone [4]. This method is often used by pediatric dentists in Serbia, but the results of this study show the largest number of the participants (38.9%) make 0–10 periapical radiographs per week. This result was also obtained by dentists in Turkey having the same answer (62.3%) [16].

A study in Ontario Canada [17] showed that on average, dentists reported making 27% of their patients' radiographs, whereas 82.5% of dentists in Turkey [16] reported that they took the radiographs themselves. The results of our research pointed out that only 8.8% of pediatric dentists in Serbia take radiographs themselves.

The majority of dentists in New Queensland [7] (79.4%) reported varying the exposure time depending on the place of interest, with the average exposure time being less than 0.16 seconds. Adjusting the exposure time according to the location of a tooth is not a common practice in Serbia.

The use of a film holder with a beam-aiming device reduces the number of overlapping contact points and improves the image quality, minimizing interpretation errors [4]. American Dental Association states dental professionals should not hold the film while exposing patients to x-rays. General dental practitioners in England and Wales [13] mostly use film holders, but pediatric dentists in Serbia do not have this habit. It can be observed that many dentists taking part in an Indian study [14] using digital radiography system do hold sensors for their patients in fear of damaging costly sensors, which is actually dangerous and could lead to damages that are hidden and have a long latent period to reveal themselves. Unfortunately, 7.9% of our participants still use the method of holding the film with their finger while taking radiographs.

Radiation protection

Dental operatories should be designed and constructed to meet the minimal shielding requirement of the state regulations; this requires consultation with a qualified expert. This recommendation states that walls must be of sufficient density or thickness that the exposure to non-occupationally exposed individuals. In most instances, it is not necessary to line the walls with lead to meet this requirement. Every effort should be made so that the operator can leave the room or take a position behind a suitable barrier or wall during the exposure. The thyroid gland is more susceptible to radiation exposure during dental radiographic exams given its anatomic position, particularly in children. Therefore, every precaution should be taken to minimize radiation exposure, and protective thyroid collars should be used whenever possible [4]. A study from Finland says the use of lead shields reduced the fetal dose by 39%–97% and reduced the breast dose by 22%–99% [8]. Leaded aprons and thyroid shields that contain lead or other materials are patient-protective equipment, which minimizes the exposure to scattered radiation [18]. Thyroid shielding with a leaded thyroid shield or collar is strongly recommended for children and pregnant women, as these patients may be especially susceptible to radiation effects [18–20]. In Turkey, a study detected only 30% of the participants answered the walls of the x-ray room were covered with lead, and even a smaller number stated they use lead aprons (8.7%) and thyroid collars (3.7%). Protective barriers were used by 11.2% of dentists participating in the study [16]. A study about the knowledge of oral radiology among Swedish dentists [21] states that 93.4% of examinees absolutely agree that it is necessary to protect a thyroid gland during intraoral radiology. The present study showed that 39.7% of dentists in Serbia have a lead-lined x-ray room, 46.8% use protective barriers, 46.4% use lead aprons and 40.5% use thyroid collars while taking radiographs.

Conclusion

Based on the conducted survey and the obtained results, it is concluded that attempts should be made in order to upgrade and update dentists' overall knowledge about the use of radiology in pediatric dentistry. The research showed a large number of pediatric dentists did not know the answers to the questions in the survey. This might be due to the fact that most pediatric dentists in Serbia do not own radiological equipment. This, however, is not an excuse for not knowing the basic indications and preventive measures in radiology. We should aspire to educate pediatric dentists, both by getting better undergraduate and postgraduate knowledge. Establishing guidelines for intraoral and extraoral radiography is a top priority. Protocols for radiographic equipment should be renewed and modified for the overall needs of pediatric dentists in Serbia.

R E F E R E N C E S

1. *Horner K.* Review article: radiation protection in dental radiology. Br J Radiol 1994; 67(803): 1041–9.
2. *Espelid I, Mejàre I, Weerheijm K.* EAPD guidelines for use of radiographs in children. Eur J Paediatr Dent 2003; 4(1): 40–8.
3. *Looe H, Pfaffenberger A, Chofor N, Eenboom F, Sering M, Rühmann A*, et al. Radiation exposure to children in intraoral dental radiology. Radiat Prot Dosimetry 2006; 121(4): 461–5.
4. *White SC, Pharoah MJ.* Oral radiology: principles and interpretation. 7th ed. St. Luis, MO: Elsevier; 2014.
5. *White SC, Heslop EW, Hollender LG, Mosier KM, Ruprecht A, Shrout MK.* Parameters of radiologic care: an official report of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 91(5): 498–511.
6. *de-Azevedo-Vaz SL, Vasconcelos KF, Rovaris K, Ferreira ND, Haiter Neto F.*A survey on dental undergraduates' knowledge of oral radiology. Braz J Oral Sci 2013; 12(2): 109–13.
7. *Ihle IR, Neibling E, Albrecht K, Treston H, Sholapurkar A.* Investigation of radiation protection knowledge, attitudes, and practices of North Queensland dentists. J Invest Clin Dent 2019; 10(1): e12374.
8. *Kelaranta A, Ekholm M, Toroi P, Kortesniemi M.* Radiation exposure to fetus and breasts from dental X-ray examinations: effect of lead shields. Dentomaxillofac Radiol 2016; 45(1): 20150095.
9. *Hajem S, Brogårdh-Roth S, Nilsson M, Hellén-Halme K.* CBCT of Swedish children and adolescents at an oral and maxillofacial radiology department. A survey of requests and indications. Acta Odontol Scand 2020; 78(1): 38–44.
10. *Giray FE, Peker S, Yalcinkaya SE, Kargul B, Aps J.* Attitudes and knowledge of paediatric dentists' on digital radiography and cone beam computed tomography. J Pak Med Assoc 2019; 69(2): 205–10.
11. *Burstein B, Upton JEM, Terra HF, Neuman MI.* Use of CT for Head Trauma: 2007-2015. Pediatrics 2018; 142(4): pii: e20180814.
12. *Oenning AC, Jacobs R, Pauwels R, Stratis A, Hedesiu M, Salmon B.* Cone-beam CT in paediatric dentistry: DIMITRA project position statement. Pediatr Radiol 2018; 48(3): 308–16.
13. *Tugnait A, Clerehugh DV, Hirschmann PN.* Radiographic equipment and techniques used in general dental practice. A survey of general dental practitioners in England and Wales. J Dent 2003; 31(3): 197–203.
14. *Agrawl B, Dosi T, Hazari A, Meheshwari C, Rajput R, Yadav N.* Evaluation of radiation protection awareness amongst general dental practitioners of Western Rajasthan in India. J Int Oral Health 2015; 7(12): 51–5.
15. *Geist JR, Katz JO.* The use of radiation dose-reduction techniques in the practices of dental faculty members. J Dent Educ 2002; 66(6): 697–702.
16. *Ilgüy D, Ilgüy M, Dinçer S, Bayirli G.* Survey of dental radiological practice in Turkey. Dentomaxillofac Radiol 2005; 34(4): 222–7.
17. *Bohay RN, Kogon SL, Stephens RG.* A survey of radiographic techniques and equipment used by a sample of general dental practitioners. Oral Surg Oral Med Oral Pathol 1994; 78(6): 806–10.
18. *American Dental Association Council on Scientific Affairs.* The use of dental radiographs: update and recommendations. J Am Dent Assoc 2006; 137(9): 1304–12.
19. *Miles DA, Langlais RP.* National Council on Radiation Protection and Measurement. NCRP report No. 145: New dental X-ray guidelines: their potential impact on your dental practice. Dent Today 2004; 23(9): 128–34.
20. *Hujoel PP, Bollen AM, Noonan CJ, del Aguila MA.* Antepartum Dental Radiography and Infant Low Birth Weight. JAMA 2004; 291(16): 1987–93.
21. *Svenson B, Söderfeldt B, Gröndahl H.* Knowledge of oral radiology among Swedish dentists. Dentomaxillofac Radiol 1997; 26(4): 219–24.

Received on November 22, 2019
Accepted on December 23, 2019
Online First December, 2019