

A Questionnaire of Digital Radiography and CBCT Use and Knowledge among Lithuanian Dentists

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ABSTRACT

Objectives: Digital radiography is an increasingly used technology in Lithuania. However, there is no published information about using cone-beam computed tomography. The aims of this cross-sectional study performed in Lithuania were (1) to obtain information about the prevalence and accessibility of digital radiography and cone-beam computed tomography usage, and (2) to estimate dental practitioners' knowledge about this diagnostic method and their need for education.

Material and Methods: Questionnaires consisting of 31 questions were distributed during the 2019 International Dentist Congress in Lithuania.

Results: This study analyses the data obtained from 248 respondents. Most of the clinicians use digital radiographic methods in their practice. The institutions usually have a digital dental X-ray machine, less often a digital panoramic X-ray machine, and least often a cone-beam computed tomography (CBCT) unit. Most dental practitioners performed 1 to 10 CBCT scans per month for adult patients and the most frequent reason for its use was implantation planning. Of the practitioners, 81.7% would like to improve their CBCT knowledge and skills.

Conclusions: The number of digital X-ray machines has increased throughout the last decade. Lithuanian dental practitioners do not excessively use cone-beam computed tomography. Some concerns were raised regarding respondents' knowledge about exposure factors and this diagnostic method's performance for paediatric patients. Additional training should be provided to Lithuanian dental specialists.

Keywords: cone-beam computed tomography; dentistry; digital radiography; questionnaire; survey.

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INTRODUCTION

In dental practice, digital radiography is a very important and frequently used technology. Dental digital radiography is a form of X-ray imaging that uses digital X-ray sensors instead of traditional photographic film. It helps to diagnose and monitor particular dental diseases and to ensure qualified dental treatment [1]. Dental practitioners commonly use digital radiographs because the technology provides a low cost to the patient and fits to the as low as reasonably achievable principles (also known as ALARA) [2]. Intraoral, panoramic and cephalometric X-rays are two-dimensional radiographic techniques. However, they have several significant limitations: the anatomical noise that can obscure the area of interest, and geometric distortion [3].

Cone-beam computed tomography (CBCT) minimizes and overcomes these particular limitations because of its three-dimensional images [3]. Although the CBCT exposed radiation dose is larger than digital X-ray radiograph, it is lower than conventional computed tomography scan and can depend on the device used, X-ray energy and filtration, which also forms the parameters used during scanning [4,5]. CBCT is a great diagnostic method in dental practice; however, dentists must be conscious of their most important ethical goal, which is to protect patients from any harm [5]. The American Dental Association Council on Scientific Affairs and the European Society of Endodontology already have position statements about CBCT usage in daily clinical practice [3,5]. It is significant to understand how CBCT should be used in dental practice in order to ensure adequate images and prepare the best treatment plan for the patient.

To our knowledge, only one study evaluated the use of digital X-ray radiography facilities and techniques in Lithuania, and no studies have been done on the indications, different parameters, and the purpose of Lithuanian dental practitioners' CBCT use [6]. The objectives of this cross-sectional study were (1) to determine the prevalence and accessibility of digital X-ray radiography and CBCT usage in practice among Lithuanian general dentists and dental specialists, and (2) to estimate their knowledge about CBCT and their need for further education and training.

MATERIAL AND METHODS

The questionnaires were distributed during the International Dentist Congress in Lithuania - "Odontologijos Kompasas 2019"

(<https://odontologurumai.lt/lt/apie-rumus/naujienos/1234-odontologijos-kompasas-2019>). The definitive survey was developed under the guidance of previous studies [4,7,8] and consisted of 31 questions (Appendix 1). All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the Ethics Committee of Lithuanian Health University, Lithuania (Protocol No. BEC-OF-89).

The sample size was estimated from the statistical data collected from the year of 2018 by the dentists of the Institute of Hygiene (Vilnius, Lithuania). There were 2,823 active Lithuanian dentists in that year. The confidence level of the sample size formula was 90%, the margin of error was 5%, and the sample size of this research was calculated at 248.

The questionnaire had two parts - the first section comprised 16 questions to gather information such as gender, age, and years since graduating, as well as the radiographic equipment in their workplace and its use. For those participants who did use CBCT technology in their clinical practice, the questionnaire included 15 further questions regarding the most common clinical indications for using CBCT, radiation protection for the patients, CBCT advantages, technical aspects of equipment, etc.

With the exception of questions 5, 15, 19, 21, 25, 26, and 29, only one answer could be selected. For questions 5 (city), 15 (the name of CBCT), and 26 (more indications of using CBCT in daily practice) participants were asked to write their own personalized response. For questions 19 (the indications of CBCT), 21 (which parameters of CBCT are changed the most), 25 (who evaluates the CBCT images), and 29 (disadvantages of CBCT) multiple answers were possible.

To make a more detailed comparison of the information, the answers were evaluated according to several factors: the duration of the dentists' age ("18 - 24"; "25 - 34"; "35 - 44"; "45 - 54"; "55 - 64"; "65 and over") work experience ("less than 5 years," "5 - 10 years," "11 - 20 years," and "more than 20 years"), workplace ("public practice," "private practice," and "public and private practice"), and specialization.

Statistical analysis

Collected data were entered into Microsoft Office Excel 2013 program (Microsoft Corporation; Washington, USA). The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 20 - SPSS Inc.; Chicago, Illinois, USA). Chi-square (χ^2) and Kendall-tau-c (τ_c)

correlation coefficient were used to calculate the data for statistical analysis. The significance level was set at $\alpha = 0.05$ and the confidence interval was set at 95%. Blank answers were considered as missing values.

RESULTS

Demographic data

A total of 448 questionnaires were distributed during the International Dentist Congress - “Odontologijos kompasas 2019”. Overall, 248 responses were received: 50 (20.2%) men and 198 (79.8%) women. The majority of respondents were from 25 to 34 years old (n = 99, 39.9%), with up to 5 years of work experience (n = 90, 36.6%). Half of the clinicians were general dentists (n = 127, 51.2%). The majority of respondents worked in a public medical institution (n = 125, 50.4%). A great number of respondents were working in major Lithuanian cities such as Vilnius and Kaunas. Descriptive statistics of the subjects are presented in Table 1.

Radiology equipment

In sum, 93.5% (n = 232) of the clinicians confirmed they use digital radiographic methods in their practice. Therefore the institutions, independent of the nature of funding, usually had a digital dental X-ray, less often a digital panoramic X-ray machine, and least often a CBCT unit. Both public (91.2%) and private (88.9%) health institutions mostly had a digital dental X-ray machine. However, private clinics had a digital panoramic X-ray machine more often (77.8%) than public health institutions (67.2%). Additionally, private clinics (30.6%) had a CBCT unit more frequently than public health institutions (22.4%). No statistically significant differences were found between the distribution of digital dental X-ray machines ($\chi^2 = 0.178$; df = 2; P = 0.915) and digital panoramic X-ray machines ($\chi^2 = 3.668$; df = 2; P = 0.16) or CBCT unit ($\chi^2 = 3.886$; df = 2; P = 0.143) in the institutions where the respondents worked.

The majority of respondents (n = 166, 67%) answered that the age of their digital radiographic equipment was up to 7 years old. Additionally, 74 (29.8%) of dentists had 8 to 15 years old digital X-ray machine. Only 6 (2.6%) respondents used a 16 to 25 year old digital X-ray machine and 2 (0.6%) had more than 26 years old digital X-ray machine. Half of the respondents (n = 130, 52.5%) did not know how often their digital X-ray machine was calibrated.

Table 1. Demographics of respondents

	Respondents	N (%)
Age (years)	18 - 24	18 (7.3%)
	25 - 34	99 (39.9%)
	35 - 44	74 (29.8%)
	45 - 54	40 (16.1%)
	55 - 64	13 (5.4%)
	65 and older	4 (1.6%)
Specialization	General dental practitioner	127 (51.2%)
	Endodontist	28 (11.3%)
	Oral/maxillofacial surgeon	17 (6.9%)
	Periodontist	16 (6.5%)
	Orthodontist	28 (11.3%)
	Prosthodontist	16 (6.5%)
	Paediatric dentist	16 (6.5%)
Work experience	Up to 5 years	90 (36.6%)
	5 - 10 years	41 (16.5%)
	11 - 20 years	74 (29.8%)
	More than 20 years	43 (17.3%)
Work institution	Public health institution	125 (50.4%)
	Private practice	36 (14.5%)
	Both public and private institution	87 (35.1%)
Workplace	Vilnius	88 (35.5%)
	Kaunas	78 (31.5%)
	Panevezys	19 (7.7%)
	Klaipeda	18 (7.3%)
	Siauliai	10 (4%)
	Alytus	8 (3.2%)
	Druskininkai, Prienai, Utena	4 for each city (1.6% for each city)
	Jonava, Mazeikiai	3 for each city (1.2% for each city)
	Kupiskis	2 for each city (0.8% for each city)
	Birzai, Gargzdai, Kursenai, Nemencine, Plunge, Raseiniai, Rokiskis, Rumsiskes, Rukla, Sakiai, Silale, Silute, Taurage, Trakai.	1 for each city (0.4% for each city)

N = number of respondents.

Also, 56 (22.5%) of the dentists answered that they “always” and 57 (22.9%) answered that they “sometimes” calibrated their digital X-ray radiograph. Only 5 (2.1%) responded that they never calibrate their digital radiograph. There were no statistical significant differences between the age of the digital X-ray machine and calibration frequency ($\chi^2 = 6.06$; df = 9; P = 0.734).

Knowledge and practice of CBCT

A great majority of respondents had heard about CBCT (n = 221, 89.1%). Only 69 (27.8%) of respondents' clinics had a CBCT machine. A third of all dentists (n = 82, 33.1%) had referred their patients for CBCT. The ones who had not referred their patients for CBCT did not continue the questionnaire. Compared to younger respondents, dentists aged 55 to 64 (n = 152, 61.5%) and 65 and older (n = 124, 50%) were the least likely to know about this diagnostic method; these differences were statistically significant ($\chi^2 = 22.078$; df = 5; P = 0.001).

All dental specialists who participated in the study stated they were aware of the CBCT method (Figure 1). General practitioners had heard about this diagnostic method least often (n = 203, 81.9%) ($\chi^2 = 18.525$; df = 6; P = 0.005).

There was a tendency that the shorter the work experience, the more often the study participants had heard about the CBCT method - most often, dentists with up to 5 years of work experience knew of it, and dentists with more than 20 years of work experience rarely knew of it ($\chi^2 = 9.472$; df = 3; P = 0.024) (Kendall's $\tau_c = 0.121$; P = 0.009) (Figure 1).

The frequency of using CBCT among dentists is shown in Figure 2. No clinician over the age of 65

and only one respondent aged from 18 to 24 had assigned this diagnostic method to patients ($\chi^2 = 12.328$; df = 5; P = 0.031). In other age groups, no statistically significant differences were found. Most often, general dentists and dental specialists aged from 35 to 44 years referred to CBCT.

The CBCT method was most often performed by prosthodontists (n = 10, 62.5%), oral and maxillofacial surgeons (n = 10, 58.8%), and orthodontists (n = 16, 57.1%) (Figure 2). Furthermore, paediatric dentists (n = 3, 18.8%) and general practitioners (n = 22, 17.3%) ($\chi^2 = 38.85$; df = 6; P < 0.001) referred to CBCT the least.

Most often dentists with 5 to 10 years of work experience (43.9%) performed CBCT, and respondents with up to 5 years of work experience performed it least often ($\chi^2 = 5.387$; df = 3; P = 0.146) (Figure 2). Overall 57 (69.5%) dentists answered that their current radiation dose for CBCT was less than for CT, 23 dentists (28.1%) did not know the answer, and 2 (2.4%) did not answer. Almost half of the dentists used CBCT on paediatric patients (n = 39, 47.6%).

Decision making and frequency of CBCT scanning

Before deciding to perform CBCT, 48 (58.5%) dentists always performed conventional radiographs

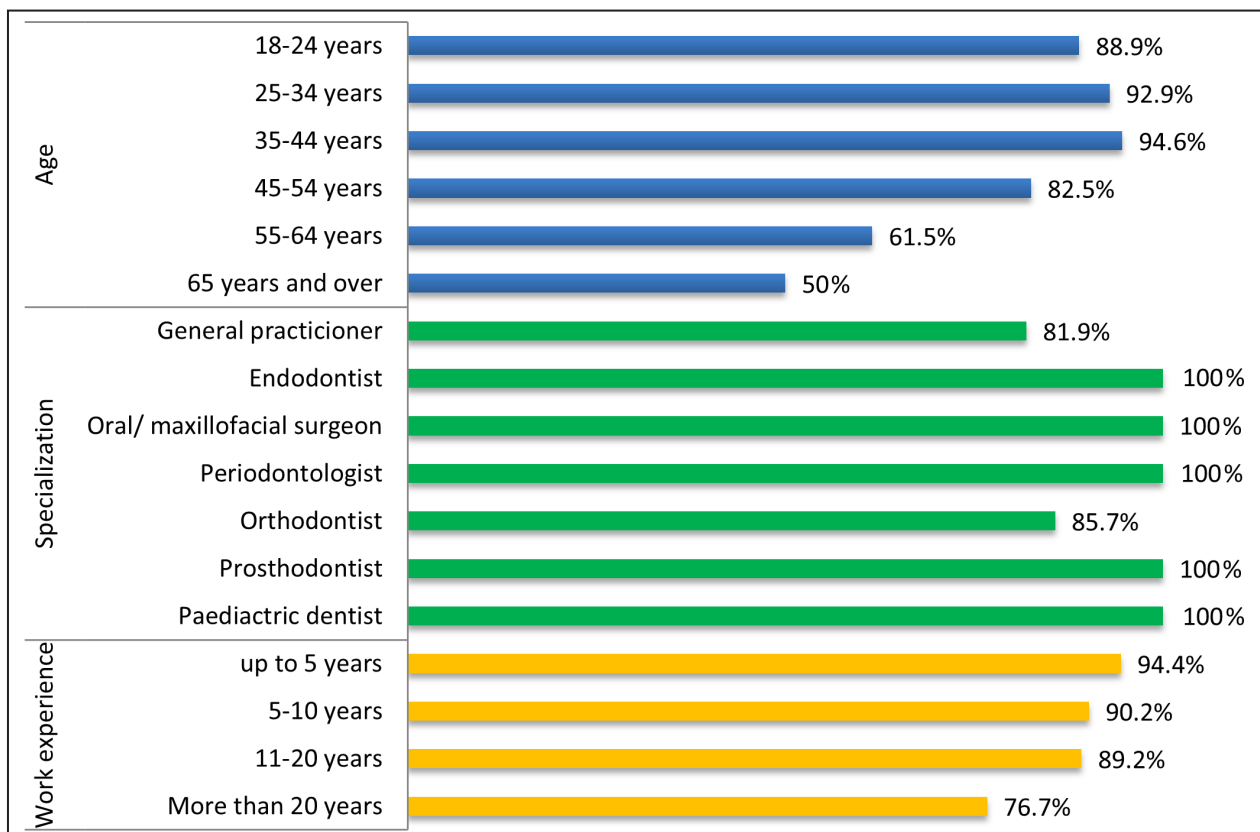


Figure 1. Response rate whether the respondent has heard about cone-beam computed tomography (CBCT) according to age, specialization and work experience.

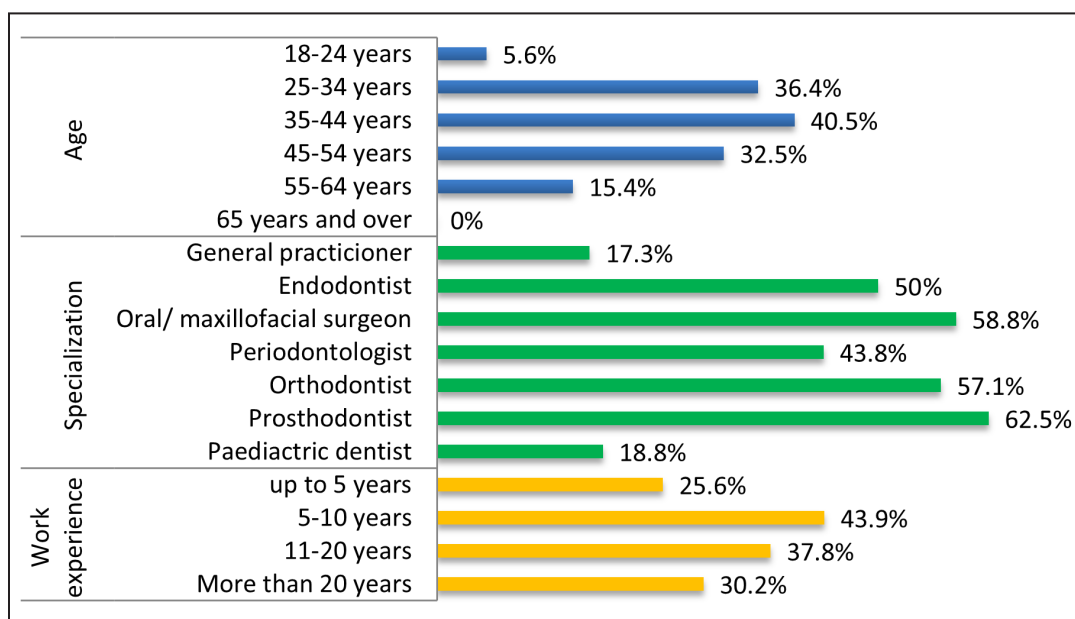


Figure 2. Distribution of performing cone-beam computed tomography (CBCT) among dentists.

(intraoral and/or panoramic), and 24 (29.3%) dentists performed them for the majority of patients. Three respondents (3.7%) said they never carried out traditional radiographs and 7 (8.5%) reported they did them only in a minority of cases.

A great majority (n = 76, 92.7%) of respondents performed CBCT scans from 1 to 10 adult patients per month. Four dentists (4.9%) performed from 11 to 20 CBCT scans and 2 (2.4%) performed from 21 to 30 CBCT scans to adult patients per month. There were no correlations between the dentist’s specialization and the frequency of CBCT scans ($\chi^2 = 20.213$; $df = 12$; $P = 0.066$).

Indications

Table 2 provides statistics on the most common cases in which the dentists of different specializations carried out CBCT.

The least common reasons were to evaluate the separated instrument in root canals (n = 2, 0.8%), cleft lip/palate cases (n = 6, 2.4%), planning for orthodontic treatment (micro-implant placement, maxillary expansion, and assessment of respiratory tract width) (n = 14, 5.6%), temporomandibular joint (TMJ) pathology diagnostics (n = 17, 6.9%), and planning for orthognathic surgery (n = 18, 7.3%), none of which were included in Table 2.

Knowledge and safety measures about CBCT equipment

The majority of respondents (n = 43, 52.4%) could not provide the detailed exposure factor settings.

Thirty-nine (47.6%) dentists used pre-programmed settings for different patient groups before taking the CBCT. The use of lead thyroid shields and lead aprons during CBCT among practitioners was average; the responses are shown in Table 3.

Reporting and training

Table 4 shows the responses to the questions about who reports the CBCT scans and if the dentist carried them out, how he was trained. When analysing the imagines, 57 (69.5%) of the dentists used accessory tools (e.g., inversion, magnification, contrast or brightness adjustment, etc.), 15 (18.3%) clinicians used them sometimes, 1 (1.2%) specialist did not use them, and 9 (11%) left the answer blank.

There were no statistically significant correlations between the dentist’s specialization and the specialty of who evaluated the pictures ($\chi^2 = 25.9$; $df = 18$; $P = 0.102$).

Comments and continuing education

One-third of respondents (n = 28, 34.3%) noted higher expenses as a drawback of CBCT, 18 (22%) dentists noted difficulties in using the software, and 16 (19.5%) respondents noted time wasted on installations and updates. The rest of the responses were noted as other reasons (n = 8, 9.7%), and 12 (14.6%) did not answer.

When asked if in 5 years CBCT scans would be performed in the dental clinical practice’s daily routine, the majority (n = 63, 76.8%) answered “yes,” though only if there were indications. Six dentists (7.3%) denied the prognosis, while 2 (2.4%) guessed

Table 2. The most common indications for CBCT scan among dental practitioners (multiple answers)

The most frequent cases for CBCT (N, % percentage, how many specialists perform CBCT)	Specialization, N (%)							χ^2
	General practitioner (n = 127)	Endodontist (n = 28)	Oral/ maxillofacial surgeon (n = 17)	Periodontist (n = 16)	Orthodontist (n = 28)	Prosthodontist (n = 16)	Paediatric dentist (n = 16)	
Implantation planning (n = 47, 57.3%)	19 (15)	2 (7.1)	10 (58.8 ^a)	7 (43.8 ^a)	4 (14.3)	4 (25)	1 (6.3)	$\chi^2 = 30.318$; df = 6; P < 0.001
Cyst - tumour (n = 38, 46.3%)	15 (11.8)	4 (14.3)	5 (29.4)	5 (31.3)	7 (25)	1 (6.3)	1 (6.3)	$\chi^2 = 11.011$; df = 6; P = 0.088
Evaluation of root resorption area and size (n = 38, 46.3%)	11 (8.7)	12 (42.9 ^a)	4 (23.5)	1 (6.3)	7 (25)	1 (6.3)	2 (12.5)	$\chi^2 = 25.736$; df = 6; P < 0.001
Evaluation of impacted teeth (n = 34, 41.5%)	11 (8.7)	0	3 (17.6)	5 (31.3 ^a)	15 (53.6 ^a)	0	0	$\chi^2 = 54.261$; df = 6; P < 0.001
Other procedures related to implantation (sinus lift, bone graft etc.) (n = 33, 40.2%)	15 (11.8)	2 (7.1)	5 (29.4 ^a)	7 (43.8 ^a)	2 (7.1)	2 (12.5)	0	$\chi^2 = 21.232$; df = 6; P = 0.002
Evaluation of supernumerary teeth (n = 33, 40.2%)	11 (8.7)	1 (3.6)	3 (17.6)	3 (18.8)	13 (46.4 ^a)	1 (6.3)	1 (6.3)	$\chi^2 = 33.374$; df = 6; P < 0.001
Bone quality evaluation (n = 30, 36.5%)	8 (6.3)	1 (3.6)	9 (52.9 ^a)	5 (31.3 ^a)	5 (17.9)	2 (12.5)	0	$\chi^2 = 41.196$; df = 6; P < 0.001
Periapical lesion evaluation and location (n = 30, 36.5%)	10 (7.9)	12 (42.9 ^a)	3 (17.6)	1 (6.3)	1 (3.6)	3 (18.8)	0	$\chi^2 = 32.834$; df = 6; P < 0.001
Dentoalveolar trauma (root splitting/fracture, avulsion etc.) (n = 29, 35.4%)	9 (7.1)	3 (10.7)	5 (29.4 ^a)	3 (18.8)	5 (17.9)	4 (25)	0	$\chi^2 = 14.469$; df = 6; P = 0.025
Periapical surgery planning (n = 28, 34.1%)	7 (5.5)	14 (50 ^a)	3 (17.6)	1 (6.3)	2 (7.1)	1 (6.3)	0	$\chi^2 = 50.14$; df = 6; P < 0.001
Evaluation of complex root canal morphology (n = 25, 30.5%)	9 (7.1)	11 (39.3 ^a)	2 (11.8)	2 (12.5)	0	0	1 (6.3)	$\chi^2 = 32.951$; df = 6; P < 0.001

^aSpecialists in this group chose this diagnostic significantly more often than other specialists, P < 0.001 (Chi-square test).
CBCT = cone-beam computed tomography; N = number of respondents in the group; χ^2 = Chi-square; df = degree of freedom.

Table 3. Use of protection gear during cone-beam computed tomography procedure

Uses lead thyroid shields		Uses lead apron	
N (%)		N (%)	
Always	49 (59.8)	Always	47 (57.3)
Sometimes	2 (2.4)	Sometimes	9 (11)
Does not use	20 (24.4)	Does not use	16 (19.5)
Did not answer	11 (13.4)	Did not answer	10 (12.2)

N = number of respondents.

that CBCT would be routinely used in all fields of dentistry. Eight (9.8%) did not know and 3 (3.7%) left the answer blank. A great majority of practitioners (n = 67, 81.7%) would like to improve their CBCT knowledge and skills. Only 3 (3.7%) respondents did not want to, the same amount did not answer, and 9 (11%) clinicians did not know if they would like to gain more knowledge about CBCT.

DISCUSSION

Radiology equipment

Nowadays, almost all dentists worldwide use digital X-ray radiography rather than conventional film radiography [9]. Digital images facilitate the sharing of images with colleagues, specialists, and patients [10]. In this study, most of the participants confirmed they use digital radiographic methods in their practice. In 2009, Peciuliene et al. [6] gathered information about the use of dental radiography among Lithuanian general dentists. According to their survey results, 91.5% of clinicians used radiography always or often during diagnostic procedures [6]. In 2009, 7.9% of dentists who were working in private clinics and 21.8% of dentists in public health institutions had a digital dental X-ray machine in their workplaces [6]. Comparing the results to present study, the number of digital X-ray machines in public health

care institutions has increased four times throughout a decade. As stated in the 2018 Radiation Protection Centre Annual Report in Lithuania [11], there were 2,127 intraoral X-ray dental and panoramic X-ray machines, 11 dental CBCT machines, and 91 hybrid two-dimensional and three-dimensional units. In comparison, in 2014 there were 1,667 dental and panoramic X-ray machines, and 6 dental CBCT machines [11]. When comparing results about digital radiography, the number of digital X-ray machines has increased both in public and private health institutions. Nevertheless, note that this survey sample is smaller than in the study of Peciuliene et al. [6].

The present study revealed, most of the dentists had a generally new (up to 7 years old) digital X-ray machine. Almost half of the respondents did not know how often the X-ray machine in their clinic was calibrated. In comparison, in 2014 a bigger part (76%) of Turkish endodontists used an X-ray machine that was up to 7 years old (77.6%) [8]. Also, 56.8% of the endodontists reported they had control of their digital radiographic equipment and 43.2% ignored the need for routine service [8]. However, in 2005, Ilguy et al. [12] reported that only 16.7% of general dental practitioners in Turkey had their digital X-ray machines calibrated routinely. To ensure a consistent level of image quality at different tube potentials, digital radiographic devices must be calibrated frequently [13]. Also, routinely servicing the digital radiographic equipment is important for radiation safety [8]. However, some of the Lithuanian dental practitioners did not seem concerned about the calibration frequency.

Knowledge and practice of CBCT

Results of the present study showed that almost 90% of respondents had heard about CBCT, though only a third of them had performed it. In comparison, 56% of the clinicians in Turkey had knowledge about CBCT and 30% had referred their patients for CBCT [7].

Table 4. Responses to the questions about reports and CBCT training

Who did the reporting of CBCT scans?		Training undertaken by the dentist, if they carried out reporting of CBCT images (multiple choices)	
N (%)		N (%)	
Always the dentist	49 (59.8)	By the company who installed the CBCT device	24 (29.3)
Usually the dentist, but sometimes radiologist	26 (31.7)	By attending an independent training course on CBCT	37 (45.1)
Usually the radiologist, but sometimes the dentist	1 (1.2)	Trained in the university	24 (29.3)
Always a specialist radiologist	6 (7.3)	Taught himself (e.g. on the internet)	28 (34.1)
		Other	2 (2.4)

CBCT = cone-beam computed tomography; N = number of respondents.

Regarding dental specialists, 66.7% of Turkish endodontists stated they were aware of CBCT and 41.9% said they had referred their patients for CBCT before [8]. The results of our study revealed that dentists with up to 5 years of work experience were significantly more likely to know about CBCT, which matches Yalcinkaya et al. [8] results of the questionnaire they performed in 2014 on Turkish endodontists. Previously, 2011 Turkish study results revealed that 56% of academicians and male dentists were more likely to know about CBCT, whereas in this study gender was not compared [7]. Also in our study, dentists over 55 years old and the general practitioners significantly had heard about CBCT the least often. These findings slightly differ from the Turkish questionnaire on paediatric dentists, where work experience had importance on CBCT knowledge, but no statistically significant correlation between age was discovered [14]. Training on CBCT is not mandatory in Lithuania and only those dentists who use an X-ray machine have to complete a course of radiation safety and do routine training to update their license. Therefore, older dentists might not have interest in learning how to use a CBCT machine because it is not demanded while young dentists in general are more susceptible to novel technologies.

One concerning result in our study was that almost half of the dentists who used CBCT, carried out CBCT scans for paediatric patients (those under 18 years of age). The ionizing radiation is a carcinogenic factor and may result in the changes of childrens DNA [15]. In comparison, most dental practitioners in the UK (91.6%) did not perform CBCT on children [4]. The effective radiation dose should be carefully estimated, especially in children, who are much more prone to stochastic biological effects and are more radiosensitive [15-17]. Theodorakou et al. [18] performed a study where doses from different CBCT machines for a 10-year-old child and adolescent phantom models were counted. Thyroid glands of 10-year-old children received 4 times more radiation than an adolescent because of the different anatomy. A recent review of the literature applicable to CBCT in paediatric dentistry revealed there still were no proper indications for using CBCT for children [15]. Van Acker et al. [19] found out that in Belgium, one of the main reasons for performing CBCT in paediatric dentistry was “developing dentition-localized,” for example, canine impaction with possible external resorption of an adjacent tooth, unerupted tooth position, localization etc. İşman et al. [20] also obtained similar results in the Turkish subpopulation where the most common indications

for CBCT were malocclusion and dentomaxillofacial anomalies in children with primary and permanent dentition, and the localization of impacted teeth in children with mixed dentition. Generally, CBCT in young age is usually used for orthodontic and surgical reasons [20].

Decision making and frequency of CBCT scanning

Present study's results revealed that before deciding to perform CBCT examination, more than a half of dental practitioners always performed digital radiographs and only a few never performed or performed on a minority of cases. In their recent UK study, Yalda et al. [4] revealed that only 36.6% of clinicians always performed and 8.4% of practitioners never performed conventional radiographs or performed on a minority of cases (7%). Horner et al. [21] wrote a review about guidelines for clinical use of CBCT. Almost all authors agreed that CBCT should only be used when conventional dental radiography or alternate imaging modalities with lower radiation doses were not helpful and more information is needed from three-dimensional images for formulating a diagnosis and/or enhancing tooth management [3,21,22]. As in our study, implant planning was reported as the main reason to perform CBCT. In implant dentistry, two-dimensional images do not provide accurate information about the maxillofacial region for diagnostic and presurgical planning purposes. Therefore, CBCT would be performed after conventional digital radiographs [23]. Besides, dental specialists usually receive referred patients with difficult treatment cases where primary diagnostic procedures have already been performed and conventional dental radiographs might have been sent with the referral [24].

One particular finding is the small number of patients reported as being scanned with CBCT in a daily dental routine. Overall, 76% of Lithuanian dentists, who performed CBCT, reported that the frequency of CBCT scans for adult patients varied from 1 to 10 patients per month. The UK results were somewhat larger because 59.2% dentists reported that they performed from 1 to 10 CBCT images, and others stated that the number of patients varied from 11 to 40 per month and over [4]. The results of a Norwegian nationwide questionnaire were also larger than Lithuanian because 72% of clinics performed an average of 4 or fewer CBCT examinations per week and 86% specialist clinics performed an average of 5 to 10 per week [25]. The low level of CBCT use in Lithuania may be explained because only a third (n = 82) of all dentists (n = 248) in our study referred

their patients for CBCT. These results can cast doubt on the economical aspect of having a CBCT unit in the dental clinic. Concerning economic effectiveness, smaller dental clinics usually refer their patients to medical institutions that have a CBCT unit rather than buying one for its clinic. However, some “hybrid” CBCT systems can be used to perform not only CBCT images, but also panoramic, lateral, and posteroanterior cephalometric radiographs, which can rise up the benefit of owning CBCT machine [26-28]. CBCT radiation doses are reduced compared to those of CT because of the use of a relatively high kV, combined with modern image receptor sensors [29]. Regarding dose reduction, 69.5% of respondents knew the difference between CT and CBCT, and almost a third of them did not know whether the radiation dose was less for CT or for CBCT. Almost identical results were found among Turkish orthodontists (specialists) [30]. Overall, Turkish dentists showed better results as 82% of respondents knew about the radiation dose difference between CBCT and CT [7].

Indications

In this study it was discovered that prosthodontists, oral/maxillofacial surgeons, and orthodontists, followed by endodontists, perform CBCT the most frequently. The main indication to perform a CBCT examination was implantation planning, significantly more often by oral/maxillofacial surgeons and periodontists. Recent surveys in the UK, Turkey, Sweden, and Norway have reported the same common reason for a CBCT examination [4,7,8,25,31]. CBCT is widely used in implant dentistry because of its ability to ensure detailed volumetric image data of the maxillofacial region [23].

Regarding specialization, endodontists in this study carried out CBCT for evaluating root resorption, periapical lesions, complex root canal morphology, and periapical surgery planning. In comparison, endodontists in the United States mostly used CBCT for diagnosing internal or external resorption and preoperatively for surgical retreatment or intentional replantation [32]. The common indications for using CBCT for Turkish endodontists were cyst-tumour, implant planning, or dental trauma [8]. Similarly, cyst-tumour and other reasons related to implantation were the most common indications after implant planning among clinicians in this study. As expected, the most common reason among orthodontists was to evaluate supernumerary teeth and impacted teeth. However, cases of the cleft lip and palate, assessing TMJ and airways were the least frequently cited

reasons, while in a 2016 Turkish orthodontist survey, those were among the most used indications [30]. The low numbers of CBCT machines in dental care institutions in Lithuania and the great variety of other available diagnostic methods could explain this difference.

Knowledge and safety measures about CBCT equipment

An interesting finding was that more than a half of the dentists interviewed used a lead apron as protection gear during a CBCT procedure. Shielding devices such as lead aprons or thyroid shields could be used to reduce the patient’s radiation dose. Nevertheless, according to the European Commission Cone Beam CT for Dental and Maxillofacial Radiology Evidence-Based Guidelines, there is no evidence for the advantages of using abdominal shielding (“lead aprons”) during dental CBCT examinations [16]. Thyroid shielding has a more positive effect on minimizing the effective radiation dose to patients with a larger field of view (FOV) or when the FOV is close to the neck. The efficacies of thyroid shielding in studies are advantageous and it may be appropriate to suggest its use for CBCT [4,33]. Around a half of respondents could not provide the detailed exposure factor settings and used pre-programmed settings for different patient groups before taking the CBCT. Using pre-programmed settings can cause accidents, when the exposure is too high or too low or the pre-selected FOV does not include the area of interest and the diagnostic procedure must be repeated because of unclear image. Therefore, all dentists should know how to use their X-ray machine.

Reporting and training

Concern arises regarding reporting CBCT images and training on this diagnostic method: there was a tendency that dentists who attended an independent course on CBCT or trained individually mostly carried out the reports. Whereas in Norway and Sweden, a specialist radiologist should report all scans that are not limited to the dento-alveolar region [31]. European Society of Endodontology posted their guidelines about assessing CBCT images [3]. Normally, in other European countries, a maxillofacial radiologist should report CBCT scans [3]. However, a clinician who has prescribed and/or taken the scan could also evaluate the image [3]. In Lithuania, a specialization of maxillofacial radiologist does not exist and thus clinicians evaluate images.

Comments and continuing education

Some dental practitioners in this study noted difficulties in using the software. This finding is similar to the study in Norway, where dental practitioners faced difficulties in image interpretation and handling the equipment [25]. Also, a third of these respondents claimed that the higher cost of the procedure was one of the negative aspects, in comparison, high cost was mentioned by over 70% of dentists in the research in Turkey and over 50% of practitioners in the United States [7,32]. However, the low response rate to this question does not represent true opinions on CBCT's drawbacks.

Dentists in Lithuania are aware of the excess use of CBCT in daily clinical routine: the vast majority of dentists predict that in 5 years, scans will be carried out only if there are indications and will not be done routinely. Moreover, a great majority of practitioners in Lithuania would like to improve their CBCT knowledge and skills. According to these findings, this study suggests more special additional training for CBCT usage in Lithuania for dental practitioners focusing on equipment handling and image reporting. According to the European Union statistics data gathered in 2018, Lithuania was among top 7 countries with the highest number of dentists per hundred thousand inhabitants [35]. On top of that, Lithuania had the second highest number of dentistry graduates in 2018 at 6.7 graduates per hundred thousand inhabitants [35]. The results of this study could represent the situation among other small member states of the EU (these countries have populations below 5 million). In our research data was compared to Sweden, Norway, Belgium, Turkey and United States studies. Only Sweden, Norway and Belgium are members of the EU. Therefore, research on CBCT use and knowledge should be done

in other similar size countries and the results should be compared.

The limitation of present study was a relatively small sample size of periodontists, prosthodontists and paediatric dentists. Also, most of the respondents were from major cities of Lithuania, which might not reflect the real situation in the country. The strengths of this study were clearly stated and fulfilled objectives and gathered determined sample size. New and updated information on current use and knowledge of radiographic methods in dentistry in Lithuania was collected.

CONCLUSIONS

The questionnaire provided updated and new information on digital radiography and cone-beam computed tomography use and knowledge in Lithuania. The number of digital X-ray machines in dental care institutions has increased throughout the last decade. The dentists and dental specialists use three-dimensional imaging techniques less frequently than in other countries. Concern arises in regard to whether a relatively high number of the respondents performed cone-beam computed tomography for paediatric patients. Even though practitioners were quite sceptical about future prognosis of its daily use, a high number wanted to improve their cone-beam computed tomography knowledge.

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Appendix 1. Questionnaire for digital radiography and CBCT use and knowledge among Lithuanian dentists

1. Gender:
 - Male
 - Female
2. Age:
 - 18-24
 - 25-34
 - 35-44
 - 45-54
 - 55-64
 - 65+
3. Specialization:
 - General dental practitioner
 - Endodontist
 - Oral/maxillofacial surgeon
 - Periodontist
 - Orthodontist
 - Prosthodontist
 - Paediatric dentist
4. Years of professional experience:
 - Up to 5 years
 - 5-10 years
 - 11-20 years
 - More than 20 years
5. City: _____
6. Workplace:
 - Public health institution
 - Private practice
 - Both public and private institution
7. Do you have a dental X-ray device in your clinic?
 - Yes
 - No
8. Do you have a panoramic X-ray device in your clinic?
 - Yes
 - No
9. How old is your dental X-ray device?
 - 1-7 years
 - 8-15 years
 - 16-25 years
 - More than 25 years
10. How often do you have your X-ray unit calibrated?
 - Routinely
 - Occasionally
 - Never
11. Do you use digital imaging techniques in your practice?
 - Yes
 - No
12. If you cannot see a periapical lesion, does it mean it is not there?
 - Yes
 - No
 - I do not know
13. Have you heard about Cone-Beam Computed Tomography (CBCT)/Digital Volumetric Tomography (DVT)?
 - Yes
 - No
14. IS there a CBCT device in your workplace?
 - Yes
 - No
15. What CBCT machine does your workplace have? If you know, write down below: _____
16. Have you ever referred your patient for CBCT imaging?
 - Yes (Go to 17th question)
 - No (The questionnaire has ended. Thank you for your responses)
17. Do you always have conventional digital radiographs (intraoral and/or panoramic radiographs) of patients before you decide to perform CBCT?
 - Always
 - Yes, for the majority of my patients
 - Yes, but only for the minority of my patients
 - No
18. Can you make an estimate of the number of adult patients (18 years of age or older) that you scan in your practice using CBCT in a typical month?
 - 1-10
 - 11-20
 - 21-30
 - 31-40
 - 41+
19. In which situation(s) do you prefer CBCT/DVT imaging? (Multiple choices are allowed)
 - Dentoalveolar trauma (eg. root splitting/fracture, avulsion etc)
 - Cyst-tumor
 - Bone quality evaluation
 - Implant planning
 - Other procedures related to implantation (eg. bone graft/sinus augmentation)
 - Evaluation of supernumerary teeth
 - Impacted teeth localization (eg. third molar; maxillary canine)
 - Cleft lip/palate
 - Planning for orthodontic treatment (micro-implant placement, maxillary expansion, assessment of respiratory tract width)
 - TMJ pathology diagnostics
 - Evaluation of complex root canal morphology
 - Evaluation of root resorption area and size
 - Separated instruments in root canals
 - Periapical lesion evaluation and location
 - Periapical surgery planning
 - Other: _____
20. What is the difference between CT and CBCT/DVT?
 - Radiation dose for CBCT is lower than CT
 - Radiation dose for CBCT is same as CT
 - Radiation dose for CBCT is higher than CT
 - I do not know
21. What exposure factors would you set for the commonest use of CBCT in your practice?
 - I do not change the exposure factors. The CBCT machine offers preprogrammed settings for different patient groups (eg. large, medium, small, man, woman, or similar)
 - I do not change the exposure factors. The CBCT machine has an automatic exposure control.
 - Milliamperage (mA)
 - Peak kilovoltage (kV)
 - Exposure time (s)
 - Field of view (FOV),
 - Voxel size
 - Other parameters

22. Do you use a lead (or lead equivalent) thyroid shield for your patients?
 Yes
 No
 Sometimes
23. Do you use a lead (or lead equivalent) apron on your patients?
 Yes
 No
 Sometimes
24. Who undertakes the reporting of the CBCT scans?
 Always the dentist who requested the scan
 Normally the dentist who requested the scan, but sometimes a specialist radiologist (dental and maxillofacial radiology or a medical radiologist)
 Normally a specialist radiologist (dental and maxillofacial radiology or a medical radiologist), but sometimes the dentist who requested the scan
 A specialist radiologist (dental and maxillofacial radiology or a medical radiologist) always reports the scan
 Other: _____
25. If the dentist within the practice reports the CBCT images, how was s/he trained?
 By the company who installed the CBCT device
 By attending an independent training course on CBCT (eg. by an academic or specialist society/ organization)
 Trained in university
 The dentist had enough information to report CBCT images without training courses
 Other: _____
26. If you do, write where additionally you use CBCT in your daily dental routine: _____
27. Do you use accessory tools (for example, inversion, magnification, contrast, brightness adjustment etc) when analyzing the images?
 Yes
 No
 Sometimes
28. Do you perform CBCT on paediatric patients?
 Yes
 No
29. What are the main drawbacks of CBCT?
 More expensive
 Difficult to use software
 Time wasting installation, updates
 Other: _____
30. In your opinion, will CBCT scans in 5 years be performed in daily routine of dental practice?
 Yes, in all fields of dentistry
 Yes, but only if there are indications
 CBCT will not be used in routine dental practice
 I don't know
31. Would you like to update your knowledge and skills about CBCT?
 Yes
 No
 I don't know