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Knowledge and attitudes towards digital radiography and CBCT among orthodontists.

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Abstract

The aim of this study was to evaluate knowledge of and attitudes towards digital radiography and Cone Beam Computed Tomography (CBCT) among orthodontists. A questionnaire with 24 questions was emailed to orthodontists practising in Turkey. The questionnaire comprised sections pertaining to demographic characteristics and clinical specialties, attitudes towards digital imaging, and knowledge of CBCT. Data from 366 questionnaires were analysed. The mean age of responders was 35 years (range: 24-68 years); 294 orthodontists (87.5%) preferred digital radiography for all procedures, with 49.4% reporting that they had learned about CBCT from seminars. A total of 206 respondents (56.3%) used CBCT during orthodontic diagnosis. The most frequently cited indication for CBCT was determination of impacted teeth and other oral abnormalities (80.9%), followed by cleft lip and palate (57.4%); 196 orthodontists (53.6%) believed that CBCT lectures should be included in the clinical phase of dental education, with 282 (77%) indicating a willingness to learn more about CBCT. Our data indicate that digital radiography is widely used by orthodontists; the preference for CBCT for evaluation of oral and craniofacial anomalies will likely increase commensurate with greater technical competence.

Keywords: Radiology, Cone beam computed tomography, Dental education.

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Introduction

Extra-oral radiographs are invaluable diagnostic tools in orthodontic treatment [1,2]; lateral cephalometric radiographs can provide information on the structural relationships between bones, teeth, and airways [1]. Most practitioners favour the use of digital radiographic techniques [3], which are being time-effective, use low doses of radiation, eliminate the requirement for chemicals and development processes, and facilitate straightforward data storage and ease of communication with colleagues (given their widespread use).

Disadvantages include the high equipment costs and provision of a two-, rather than three-, dimensional (3D) view [4,5]. 3D views can be obtained using computed tomography (CT). In the field of dentistry, CT scanners have typically not been used because of concerns regarding radiation dose and cost [6]. By the early 2000s, commercially available cone beam CT (CBCT) had become popular for the visualization of oral and maxillofacial regions [7,8]. CBCT has several advantages over conventional CT, including reduced cost and space requirements, a more rapid scan time, and reduced beam application time to the head and neck [1,9-13].

3D visualisation of the craniofacial complex can improve orthodontic treatment planning, airway analysis, evaluation of temporomandibular joint (TMJ) dysfunction, orthognathic surgical planning, and understand facial asymmetry [10,13-16]. We herein evaluate orthodontists' knowledge and attitudes towards digital radiography and CBCT using a detailed questionnaire.

Materials and Methods

A questionnaire with 24 questions was emailed to a total of 705 orthodontists and dental students undertaking postgraduate orthodontic programs who were members of the Turkish Orthodontics Society (TOD). Each email was provided with a letter of presentation of the aim of the study. Over a 3-month period, two e-mail reminders were sent. 366 questionnaires were returned which means an overall response rate 51.9%. The questionnaire was divided into the following three sections (Figure 1) 1) demographic characteristics and clinical specialities (questions 1-4); 2) attitudes towards digital imaging (questions 5-10); and 3) knowledge of CBCT (questions 11-24).

Study data were compiled using Microsoft Office Excel 2007 (Microsoft, Redmond, WA, USA). Data were analysed using the SPSS for Windows software package (ver. 21.0; IBM Corp., Armonk, NY). The Shapiro-Wilk test was used to assess the normality of age and tenure data. The Mann-Whitney U- and Kruskal Wallis tests were used to compare tenure length and home institution data. Chi-squared tests were used to analyse categorical variables. A p value of<0.05 was considered statistically significant.

1- Gender: () Female () Male

2- Age:……

3- Title:
()Dental student on a postgraduate orthodontic program
() Doctor or specialist

4- Institution:
() University () Public oral and dental health centres
() Oral and dental health centres () Clinic

5- How many years have you been working as an orthodontist?
(Since the first year of the postgraduate orthodontic programs)**:**.....

6- Do you use digital imaging techniques when obtaining radiographs? () Yes () No

If you answered "*No"* to question 7, please go to question 11.

7- For which type of radiography do you use digital imaging?
(a) Panoramic (b) Periapical
(c) Cephalometric (d) Posteroanterior (e) All

8- Please indicate your reasons for using digital imaging techniques (multiple selection is permissible)
() Radiation dose is reduced
() Time to perform is less
() Opportunity for instant assessment
() Ease of image storage
() Images can be adjusted
() Measurements can be performed on images
() Environmental harm is reduced

9- Are you satisfied with digital imaging?
() Not at all () Somewhat satisfied () No idea
() Satisfied () Very satisfied

If you answered "*Yes*" to question 11 please go to question 12.

10- Please indicate why you do not use digital imaging techniques:
() Expensive
() Poor image quality
() I do not have the necessary equipmens
() I do not know how to use a computer
() Difficult to perform
() Imaged area is insufficiently wide
() Technical problems might occur during image storage

11- Are you familiar with cone beam CT (CBCT) use specifically for dentomaxillofacial imaging?
() Yes () No

12- How did you obtain information regarding CBCT?
() Faculty lessons () Seminars () Internet
() Other (please specify):……

13- Have you attended any courses or seminars concerned with CBCT?
() Yes () No

14- Which method do you prefer for three-dimensional (3D) imaging of the neck and head?
() CBCT () Computed tomography (CT)

15- Please rank the following advantages of CBCT over CT from the most- (1) to least-important (6):
() Lower radiation dose
() Less expensive
() Shorter scanning time
() Occupies less space
() Easier to maintain
() Image processing is easier due to the limited beam
() No idea

16- Do you use CBCT for orthodontic diagnosis?
() Yes () N**o**

17- In which cases would you prefer to use CBCT ?
() Determination of impacted teeth and oral abnormalities
() Airway analysis
() Evaluation of alveolar bone height, volume, and development
() Evaluation of temporomandibular joint morphology
() Facial analysis
() Cleft lip and palate analysis
() 3D superimposition
() Rapid prototyping
() Other (please specify):……
() No idea

18- What is your opinion of 3D cephalometry?
() Must be used
() Only to be used in special cases (e.g., surgery, etc.)
() Unnecessary for the moment but will be used in the future
() Unnecessary

19- Which year of dental education should include lectures on CBCT?
() Preclinical phase () Clinical phase
() Postgraduate program () Should not be included at all

20- Is there a dental CBCT at your institution now?
() Yes () No

21- Do you think a dental CBCT unit should be available at your institution?
() Yes () No () No idea

22- Would you choose to use CBCT in your future professional career?
() Yes () No () No idea

23- Do you believe that you have received adequate education regarding CBCT?
() Yes () No () No idea

24- Are you willing to receive further information regarding CBCT?
() Yes () No () No idea

Figure 1. Study questionnaire

Results

Data from 366 questionnaires were analysed. The mean age of respondents was 35 years (range: 24-68 years). Of this number, 266 (72.7%) of the respondents were doctor or specialist; 100 (27.3%) were dental student on a postgraduate orthodontic program. A total of 196 males, 170 females participated in this study. Descriptive statistics are provided in Table 1. A total of 336 orthodontists (91.8%) used digital imaging techniques to obtain radiographs, of whom 294 (87.5%) preferred digital radiography for all types of analysis (panoramic, periapical, cephalometric, and posteroanterior). Orthodontists indicated a preference for digital imaging for the following reasons: instant assessment (82.7%, n=278), ease of image storage (69.6%, n=234), the possibility of performing measurements directly on images (66.1%, n=222), rapid application (63.7%, n=214), reduced radiation (58.9%, n=198), adjustment directly on images (46.4%, n=156), and less harm to the environment (36.9%, n=124).

Table 1. *Demographic characteristics of respondents.*

	n	%
Gender		
Male	196	53.6
Female	170	46.4
Title		
Doctor or specialist	266	72.7
Dental student on a postgraduate orthodontic program	100	27.3
Institution		
Clinic	98	26.8
Oral and dental health centers	60	16.4
University	208	56.8

Table 2. *Advantages of CBCT vs. CT cited by respondents.*

	1st n (%)	2nd n (%)	3rd n (%)	4th n (%)	5th n (%)	6th n (%)
Lower radiation dose	226 (83)	10 (3.9)	8 (3.1)	0 (0.0)	0 (0.0)	12 (4.7)
Reduced scanning time	0 (0.0)	124 (48.4)	82 (32.0)	36 (14.1)	12 (4.7)	2 (0.8)
Image processing is easier due to limited beam use	16 (6.3)	58 (22.7)	86 (33.6)	56 (21.9)	26 (10.2)	14 (5.5)
Less expensive	0 (0.0)	58 (22.7)	54 (21.1)	66 (25.8)	42 (16.4)	36 (14.1)
Occupies less space	2 (0.8)	6 (2.3)	16 (6.3)	64 (25.0)	100 (39.1)	68 (26.6)
Easier to maintain	12 (4.7)	0 (0.0)	10 (3.9)	32 (12.5)	76 (29.7)	126 (49.2)

Table 3. *Specific clinical cases for which CBCT is used.*

Clinical Cases	n	%
Determination of impacted teeth and oral abnormalities	296	80.9
Airway analysis	118	32.2
Evaluation of alveolar bone height, volume and development	116	31.7
Evaluation of temporomandibular joint morphology	144	39.3
Facial analysis	72	19.7
Cleft lip and palate analysis	210	57.4
3-D superimposition	78	21.3
Rapid prototyping	90	24.6
Other	8	2.2
No idea	50	13.7

A high proportion (66.7%, n=224) of respondents were satisfied with currently available digital imaging techniques; non-use of digital systems was attributed to equipment unavailability (73.3%) and cost (26.6%).

Table 4. *Respondents' suggestions regarding CBCT education timing.*

CBCT education timing	n	%
Preclinical phase	32	8.7
Clinical phase	196	53.6
Postgraduate program	130	35.5
No requirement for CBCT at all	8	2.2

A total of 49.4% of respondents indicated that they had learnt of CBCT from attending seminars; 310 respondents (85.6%) preferred CBCT to CT when 3D-imaging of the neck and head was required, and 206 (56.3%) used CBCT for orthodontic diagnosis. The most frequently cited advantage of CBCT over CT was lower radiation dose (83%), followed by shorter scanning time (48.4%; Table 2); 110 orthodontists (30.05%) reported that they were unaware of the advantages conferred by CBCT vs. CT. The most frequently cited indication for CBCT was to explore impacted teeth and other oral

abnormalities (80.9%), followed by cleft lip and palate (57.4%; Table 3).

Table 5. *Respondents attitudes towards CBCT.*

Questions	Yes	No	No idea
	n (%)	n (%)	n (%)
Do you think it is necessary for a dental CBCT unit to be available at your institution?	230 (62.8)	80 (21.9)	56 (15.3)
Would you choose to use CBCT in your future professional career?	306 (83.6)	14 (2.8)	46 (12.6)
Do you believe that you have received adequate education regarding CBCT?	80 (21.9)	264 (72.1)	22 (6.0)
Are you willing to receive further information regarding CBCT?	282 (77.0)	58 (15.8)	26 (7.1)

Table 6. *Digital radiography preference and attitudes towards CBCT according to institution.*

	Clinics n (%)	Oral and dental health centers n (%)	Universities n (%)	χ^2	P
For which kind of radiography do you use digital imaging?				15.433	**0.040**
Panoramic	8 (9.1)	6 (10.3)	2 (1.1)		
Periapical	4 (4.5)	0 (0.0)	2 (1.1)		
Cephalometric	8 (9.1)	4 (6.9)	6 (3.2)		
Posteroanterior	2 (2.3)	0 (0.0)	0 (0.0)		
All	66 (75.0)	48 (82.8)	180 (94.7)		
Have you of CBCT use specifically for dentomaxillofacial imaging?				13.408	**0.002**
Yes	84 (85.7)	48 (80.0)	204 (98.1)		
No	14 (14.3)	12 (20.0)	4 (1.9)		
Do you think it is necessary for a dental CBCT unit to be available at your institution?				91.457	**<0.001**
Yes	18 (18.4)	24 (40.0)	188 (90.4)		
No	58 (59.2)	20 (33.3)	2 (1.0)		
No idea	22 (22.4)	16 (26.7)	18 (8.6)		
Would you choose to use CBCT during your future professional career?				15.502	**0.004**
Yes	72 (73.5)	42 (70.0)	192 (92.3)		
No	8 (8.2)	2 (3.3)	4 (1.9)		
No idea	18 (18.4)	16 (26.7)	12 (5.8)		

Table 7. *Respondents attitudes towards CBCT according to job title.*

	Doctor or specialist n (%)	Dental student on a postgraduate orthodontic programs n (%)	χ^2	P
Are you willing to receive further information regarding CBCT?			7.242	**0.027**
Yes	194 (72.9)	88 (88.0)		
No	54 (20.3)	4(4.0)		
No idea	12 (6.8)	8 (8.0)		

270 respondents (74.2%) reported that 3D cephalometry should be used only in certain cases (i.e., for surgery). A total of 240 respondents (65.6%) reported that there was no CBCT unit in their dental institution. The majority of respondents (53.6%) believed that CBCT lectures should be included in the clinical phase of dental education (Table 4). The respondents' favoured approaches towards CBCT use is illustrated in Table 5. A total of 230 respondents (62.8%) reported that it was necessary for a dental CBCT unit to be available at their institution; 306 respondents would choose to use CBCT in their future professional career. The extent of preference for digital radiography differed significantly according to working institution ($p<0.05$; Table 6), as did attitudes towards CBCT ($p<0.001$; Table 6).

A significant association was observed between willingness to acquire further knowledge on CBCT and job title (p=0.027; Table 7). The median tenure of orthodontists who attended CBCT-related courses was 6 years (interquartile range [IQR]=8 years) compared with 10 years (IQR=11) for those not attending CBCT-related courses. There were significant associations between CBCT course attendance history, years of dental education, and attitudes towards CBCT (p<0.05 and p<0.001, respectively; Table 8).

Table 8. CBCT course attendance history and respondents' attitudes towards CBCT according to length of tenure.

	Tenure (y)	Test Statistics	p
	Median (IQR)		
Did you attend any courses related to CBCT?		2.207	0.027
Yes	6.0 (8.0)		
No	10.0 (11.0)		
Which year of dental education should include lectures on CBCT?		8.070	0.045
Preclinical phase	10.5 (7.0)		
Clinical phase	7.0 (11.0)		
Postgraduate program	11.0 (12.0)		
There is no need	10.5 (12.0)		
Do you think it is necessary for a dental CBCT unit to be available at your institution?		28.974	<0.001
Yes	6.0 (9.0)		
No	14.0 (8.0)		
No idea	12.50 (15.0)		

Discussion

A preference for digital vs. conventional radiographs is increasing among dentists commensurate with technological advances [4-6,17]. Wenzel and Møystad [18] reported use of digital radiography by 14% of their sample of dentists in 2001, compared with 67% in a 2011 study by Dolekoglu et al. [4]. No previous study has assessed attitudes towards, and knowledge of, digital radiography among orthodontists. The principal aim of the present study was to evaluate the extent of interest in digital radiography and CBCT among orthodontists, of whom a high proportion (91.8%) using digital imaging techniques were also aware of CBCT. Digital radiography was preferred due to the ability thereof to facilitate instant assessment (indicated by 82.7% of our sample) and ease of image storage (69.6%). Several other studies evaluating dentists' attitudes towards digital radiography reported different reasons for the popularity thereof such as time efficiency, absence of a need to develop images, ease of image storage, and reduced radiation [4-6,18]. We suggest that digital radiography may be of particular value for orthodontists because it allows rapid decisions to be made on optimal treatment plans.

In the present study, a significant difference (p<0.05) was observed between the prevalence of digital and non-digital radiography use according to type of institute; a similar result was reported by Dolekoglu et al. [4]. The highest rate of digital radiography use occurred in universities (among academics and postgraduate students). A high proportion (87.5%) of our sample preferred digital radiography for all types of analysis (panoramic, periapical, cephalometric, and posteroanterior). A higher proportion of respondents situated within academic institutions (90%) reported using all types of digital radiographic techniques compared with oral dental health centres (82.8%) and clinicians (75%). In previous studies on dentist populations, periapical radiography was the most-preferred technique [5,6]; this was not the case in the present study, but our sample was comprised of orthodontists.

The major disadvantages of digital radiography include reduced spatial resolution, and limited sensor size and flexibility [19,20], although 66.7% of our sample indicated satisfaction with the currently available techniques, a similar proportion to that reported by Reddy et al. [6]. Non-availability and cost of equipment were the major reasons cited for non-use of digital techniques, in accord with previous studies [4-6,18]. In our study, respondents with knowledge of CBCT preferred CBCT to conventional CT when 3D imaging of the head and neck region was required, primarily because of the lower associated radiation dose. The most frequently cited indication for CBCT was detection of oral and craniofacial anomalies such as impacted teeth (80.9%) and cleft lip and palate (57.4%). No respondent indicated routine usage of CBCT, suggesting that orthodontists tend to adhere to the 'as low as reasonably achievable' principle. Because we sampled orthodontists and not dentists, the main reasons cited for CBCT referrals differed from previous studies (i.e., dental implant planning, pathology, and TMJ analysis) [4,6,13,21]. CBCT is recommended as a low-cost dose-sparing technique compared with CT, though CBCT has slightly more radiation exposure than routine panoramic radiography for dentomaxillofacial imaging. All potential benefits of CBCT imaging must be weighed against potential risks [22,23].

Approximately half (49.4%) of our sample indicated that they had learnt of CBCT from seminars; several respondents graduated before CBCT came into existence approximately 15 years ago (which may explain this result), which also accords with previous studies of dentists and dental students [6,21]. The majority of our respondents (53.6%) indicated that CBCT lectures should be included during the clinical phase of dental education; if the radiation dose associated with CBCT continues to decrease, it is likely that CBCT use will commensurately increase [4,6,21]. Respondents suggested that their knowledge of CBCT was defective because familiarity with the technique is not considered a necessity for orthodontists, in contrast to oral and maxillofacial radiologists; collaboration between orthodontists and oral radiologists during formulation of treatment plans may therefore be advantageous. The majority of our university-based respondents (90.4%) indicated that a CBCT unit is necessary in their institution, compared with 40% of clinicians and only

18.4% of oral and dental health centre orthodontists. This may be because communication with oral radiologists is easier in a university setting, and universities are typically centers of 'leading-edge' technology.

Post-graduate student demand for CBCT was higher compared to that of active practitioners working for>10 years, with the requirement for 3D information and attendance at more CBCT seminars representing the reasons cited. Technical incompetence was among the reasons cited for non-use of CBCT [4,6]. One limitation of our investigation was response rate. The response rate of the present report was not so high (51.9%). In fact, similar studies presented the same problem. However, a random sample should be representative of the community surveyed. Our data indicate that digital radiography use is prevalent among orthodontists. Also, knowledge of CBCT and awareness of radiation safety have reached higher levels. The main reason cited for use of CBCT was the reduced radiation dose compared with conventional CT. CBCT use is higher at universities because of their status as 'leading edge' technological institutions. This high-quality imaging technology should be adopted by orthodontists with appropriate CBCT education courses, meetings and seminars.

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