

Knowledge and attitudes of Turkish endodontists towards digital radiology and cone beam computed tomography

S Ercalik Yalcinkaya, Y Garip Berker¹, S Peker², FB Basturk¹

Departments of Dentomaxillofacial Radiology, ¹Endodontics, ²Paediatric Dentistry, Faculty of Dentistry, Marmara University, Istanbul, Turkey

Abstract

Introduction: The aim of this study was to assess the knowledge and attitudes of Turkish endodontists toward digital radiological imaging (DRI) and cone-beam computed tomography (CBCT).

Materials and Methods: One hundred and fifty questionnaires were distributed. Questionnaires were given to a sample of endodontists and PhD students in endodontics who attended the 11th International Congress of the Turkish Endodontic Society in Istanbul in 2012. Following the congress, the same questionnaires were sent electronically to endodontists who did not attend the congress. The participants were asked to answer 28 multiple-choice questions concerning their knowledge and practice regarding recent imaging techniques. The questions were subdivided into 2 main topics; general information; general approach to digital imaging. The statistical analysis was carried out by an χ^2 -test to compare the means at a significance level of $P < 0.05$.

Results: The response rate for this study was 74%. The mean age of the endodontists who participated in this study was 32.74 ± 10.40 (range 22-61 years). Of the endodontists, 76.6% used digital imaging techniques (DUEs) in their clinics. Statistically significant differences were found between the DUEs and endodontists not using digital imaging (NDUEs), regarding age, gender, graduation year and place of employment ($P < 0.01$). Endodontists 40-years-old and above had significantly lower knowledge of CBCT compared to the younger groups ($P = 0.001$).

Conclusions: The number of endodontists using digital imaging has been increasing in Turkey. The findings of the present study highlighted the need for adapting to new technologies via continuing education.

Key words: Cone-beam computed tomography, digital imaging, knowledge, questionnaire

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Introduction

Researchers have investigated the use of digital radiological imaging (DRI) in various countries. In 2000, it was estimated that 5% of dental practitioners in North America used digital radiography in their practice.^[1] In studies conducted in Norway, the usage rate was estimated to be 11-14%^[2,3] and in the Netherlands it was estimated as 12%.^[4] In an earlier study conducted in the state of Indiana, USA,^[5] 19.7% of dental practitioners indicated that they were using digital

radiography, whereas in the aforementioned study, two out of four endodontists reported that they were using digital radiography.

Digital radiography has been used increasingly for over a decade in Turkish dental practices^[6-8] In a previous study conducted in Turkey, 67% of dentists and 96% of academics indicated that they used DRI, and 55.9% of dentists and

Address for correspondence:

Dr. SE Yalcinkaya,
Department of Dentomaxillofacial Radiology,
Faculty of Dentistry, Marmara University,
Buyukciftlik sk. 6 Nisantasi, 34365 Istanbul, Turkey.
E-mail: sebnemer@rocketmail.com

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79.1% of academics had knowledge about cone-beam computed tomography (CBCT).^[6] In that study, dentists' knowledge and practices in dental radiology were not evaluated according to their specialties; therefore, it was not possible to predict the frequency of the use of DRI amongst endodontists.

Dental radiology has always played a major part in endodontics. Traditionally, radiography is used to evaluate pre-, intra-, and post-treatment of patients.^[9] Recent improvements in digital dental radiology have included not only technological advances but also enhanced resolution of images, which is of great importance in endodontics since only high-quality images show canal morphology and periapical area accurately.^[10-12] To provide three-dimensional imaging, use of CBCT was proposed in the practice of endodontics and a joint position statement by the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology was announced. For most endodontic applications, limited-volume CBCT has been recommended. Although CBCT is limited to the diagnosis and treatment of only more complex endodontic conditions, it remains the method of choice compared to two-dimensional imaging.^[13]

General dental practitioners in Turkey perform root canal treatments on a daily basis.^[14] Previous studies have included general dentists and specialists of various fields, but no study has investigated the use of digital imaging and CBCT, specifically by endodontists. Thus, the primary objectives of this study were (1) to determine the prevalence of DRI and CBCT usage in Turkish endodontists and their accompanying reasons for using or not using digital radiography and CBCT, and in addition, (2) to assess their degree of knowledge regarding new imaging systems and their need for education in that area.

Materials and Methods

A total of 150 questionnaires were distributed. The questionnaire was developed with guidance of previous studies.^[6-8,16,17] Seventy questionnaires were given to a sample of endodontists and PhD students in endodontics, who attended the 11th International Congress of the Turkish Endodontic Society in Istanbul in 2012 [Figure 1]. Following the congress, the same questionnaires were sent electronically to 80 endodontists who did not attend the congress. The participants were asked to answer 28 multiple-choice questions. The questions were subdivided into 2 main topics:

- Demographic data: Age, gender, years of professional experience, working situation (e.g. PhD student, private practice, university)
- General approach to digital imaging: Use of digital imaging and radiographic equipment, methods, knowledge and practice of digital imaging.

Multiple responses were allowed in five questions. Other questions in the survey used a five-point Likert answer scale: 'never', 'rarely', 'sometimes', 'very frequently', and 'always' as well as 'strongly disagree', 'disagree', 'neither agree or disagree', 'agree' and 'strongly agree'.

A total of 111 questionnaires consisting of 28 questions were available for analysis. The collected data was entered into a personal computer and analyzed using Statistical Package for the Social Sciences (SPSS) software version 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Data was evaluated according to descriptive statistics, which are presented as frequencies (n) and percentages (%). A chi square test was used to determine the significance of differences between age/years of experience in endodontics and knowledge. The level of significance was set at 5%. Unanswered questions were treated as missing values.

Results

Response rate

The response rate for this study was 74%. From the 150 questionnaires distributed, 111 were deemed usable. Fifty-two out of 70 questionnaires were collected during the congress. Of the 80 questionnaires sent electronically to the endodontists who did not attend the congress, 69 responses were gathered.

Demographic data

The mean age of the endodontists who participated in this study was 32.74 ± 10.40 (range 22--61 years). The demographic characteristics of the endodontists are shown in Table 1. Most of the endodontists had 1-10 years of professional experience (10.33 ± 10.36 years; range: 1-37 years, median: 6 years). It was noted that 53.2% of the endodontists were working at a university and 11.7% were PhD students (at a university). Only 18.9% were private endodontic practitioners and 16.2% were employed at hospitals or dental clinics.

Use of digital imaging

The majority of the respondents (76.6%) reported using digital imaging. Statistically significant differences were found between digital imaging using endodontists (referred to as DUEs) and endodontists who did not use digital imaging (NDUEs) regarding age, gender, years of professional experience and type of practice ($P < 0.01$), Table 1.

The reason (s) for using and not using DRI are shown in Table 2. According to age and type of practice, no statistically significant difference was found regarding the reasons other than the given reason 'image settings and measurements are possible'. This answer was found to be statistically significant in the 20-29-year-old DUEs group ($P = 0.005$). When the same question was analyzed according to years of professional

experience, only the reason 'relatively lower radiation dose' was found to be statistically significant in the 40-year-old and greater DUEs group ($P = 0.046$). There was no statistically significant difference between male and female endodontists regarding the reasons to use digital imaging.

On evaluation of the reasons 'not to use DRI', there were no statistically significant differences according to age, gender and type of practice. Only the reason 'being expensive' was found to be statistically significant in the groups of graduates over 10 and 20 years of age ($P = 0.036$).

Fifteen of twenty-six (57.7%) of the NDUEs indicated that they planned to frequently use digital imaging techniques in the future.

Table 1: Demographic data of the endodontists and statistical evaluation of endodontists using digital imaging and not using digital imaging

Use of digital radiological imaging	n	%	DUEs n (%)	NDUEs n (%)	P
Age					
20-29	59	53.2	53 (89.8)	6 (10.2)	0.001**
30-39	29	26.1	23 (79.3)	6 (20.7)	
40<	23	20.7	9 (39.1)	14 (60.9)	
Gender					
Female	61	55.0	53 (86.9)	8 (13.1)	0.005**
Male	50	45.0	32 (64.0)	18 (36.0)	
Type of practice					
PhD student	13	11.7	66 (89.2)	8 (10.8)	0.001**
Private Practice	21	18.9	12 (75.0)	4 (25.0)	
Clinic-Hospital	18	16.2	7 (33.3)	14 (66.7)	
University	59	53.2	11 (84.6)	2 (15.4)	
Years of professional experience					
1-9	74	66.7	10 (47.6)	11 (52.4)	0.001**
10-19	16	14.4	10 (55.6)	8 (44.4)	
20<	21	18.9	54 (91.5)	5 (8.5)	

Chi-square test** $P < 0.01$, DUEs=Digital imaging using endodontists, NDUEs=Not using digital imaging

Table 2: Reasons for using or not using digital radiological imaging

Reasons for using DRI (n=85)	%	Reasons for not using DRI (n=26)	%
Relatively lower radiation dose	74.1	Expensive	50.0
Easy and fast to maintain	78.8	Poor image quality	3.8
No developing process	81.2	I do not have essential equipment	30.8
No wastage due to developing process, so environment friendly	56.5	I do not know how to use a computer	11.5
Easy to store images	72.9	Hard to perform	3.8
Image settings and measurements are possible	61.2	I have no idea	34.6
No artifacts due to developing process	52.9		

DRI=Digital radiological imaging

Of the DUEs, 95.3% used periapical radiography, whereas 71.8% used panoramic radiography for digital imaging. The frequency of use of DRI was indicated as 'always; 77.6%' and 'very frequently; 20%' by the DUEs. 75.3% of the DUEs found the quality of the digital images satisfactory.

Of the DUEs, 63.5% stated that digital imaging increased the number of repetitions of film taking. Moreover, 45.9% of the DUEs had difficulty placing the oral digital sensors. Of the DUEs, 25.9% were using smaller sensors for pediatric patients.

Use of radiology equipment

The dental X-ray devices used by the DUEs were generally new: Up to 7 years old (77.6%) and 7-15 years old (20%). Only one respondent's device was more than 25-years old.

Of the DUEs, 56.6% had panoramic X-ray equipment in their clinics, 10.4% of which were conventional film, 43.8% were photostimulable storage phosphor (PSP), and 45.8% were charge-coupled device or complementary metal oxide silicon (CCD/CMOS) sensor systems. Only 15.3% of the DUEs said that they used a film holder when taking digital images. Of the DUEs, 88.2% set the exposure time to be shorter than with conventional radiography.

Only 25.7% of endodontists reported that their X-ray units had been serviced routinely, 31.1% occasionally, and 43.2% never serviced their X-Ray units.

Methods of digital imaging

Use of various sensors for digital imaging is shown in Table 3. Of the DUEs, 70.6% were PSP users, 25.9% were CCD/CMOS users, and 3.5% used both. A statistically significant difference was found between the imaging systems used and type of practice. Use of SPS was found to be relatively higher than CCD/CMOS in the group of PhD students and academics (employed at a university), ($P = 0.006$).

Eighty percent of the DUEs stated that if they were to buy a new digital imaging system, they would prefer the PSP.

Knowledge and practice of CBCT

Of the endodontists, 66.7% stated that they had knowledge of CBCT. Of this group, 41.9% said that they had referred their patients for CBCT before. Regarding the dose reduction, 62.2% knew the difference between CT and CBCT.

Reasons for referring patients to CBCT were stated as: Cyst-tumor; 82.4%, implant planning; 71.6%, trauma; 50%, to indicate the resorption area; 32.4%, to examine the morphology of the root canal; 25.7%, to detect the exact place of broken files; 16.2%.

There was no statistically significant difference between male and female endodontists according to previous

Table 3: Use of digital sensors according to age, type of practice and years of professional experience

Digital sensors	CCD/CMOS n (%)	PSP n (%)	Both n (%)	P
Age (years)				
20-29	12 (22.6)	41 (77.4)	0 (0)	0.133
30-39	8 (34.8)	13 (56.5)	2 (8.7)	
40<	2 (22.2)	6 (66.7)	1 (11.1)	
Type of practice				
PhD student	0 (0)	11 (100.0)	0 (0)	0.006**
Private Practice	7 (70.0)	3 (30.0)	0 (0)	
Clinic-Hospital	4 (40.0)	5 (50.0)	1 (10.0)	
University	11 (20.4)	41 (75.9)	2 (3.7)	
Years of professional experience				
1-9	18 (27.3)	47 (71.2)	1 (1.5)	0.369
10-19	3 (25.0)	8 (66.7)	1 (8.3)	
20<	1 (14.3)	5 (71.4)	1 (14.3)	

Chi-square test ** $P < 0.01$, CCD/CMOS=Charge-coupled device or complementary metal oxide silicon, PSP=Photostimulable storage phosphor

knowledge of CBCT. When years of professional experience were evaluated, endodontists over 40 years of age had significantly less knowledge of CBCT than younger endodontists ($P = 0.001$). Academics and PhD students in endodontics had significantly greater knowledge of CBCT compared to the endodontists working in private practice and clinics ($P = 0.002$), [Table 4].

Continuing education

Of the endodontists, 66.2% indicated that they updated their knowledge by attending congresses, 12% by conferences and continuing education courses with credits, 55.4% via internet, 55.4% by reading books and journals, and 37.8% by materials provided by company representatives.

Discussion

This study gathered information about the attitudes of Turkish endodontists toward DRI. The endodontists mentioned in this study were either attendees of the 11th International Congress of the Turkish Endodontic Society or the members of Turkish Endodontic Society whose e-mail addresses were accessible electronically. The number of members of Turkish Endodontic Society was reported as 331,^[15] approximately three quarters of which are actively working. For these variables, we can accept that the distribution of the present sample is representative for the total Turkish endodontic population. The questionnaire was developed with guidance of previous studies.^[7,8,16,17] Response rate was similar to the study conducted in the Netherlands^[4] and was relatively higher compared to the one in the USA.^[5]

Radiology is an integral part of endodontic practice and is recognized as a main diagnostic aid.^[10] It enhances the

Table 4: Endodontists' knowledge of CBCT according to demographic distribution

Had previous knowledge of CBCT	Yes n (%)	No n (%)	P
Age			
20-29	47 (79.7)	12 (20.3)	0.001**
30-39	21 (72.4)	8 (27.6)	
40<	6 (26.1)	17 (73.9)	
Gender			
Female	42 (68.9)	19 (31.1)	0.589
Male	32 (64.0)	18 (36.0)	
Years of professional experience			
1-9	58 (78.4)	16 (21.6)	0.001**
10-19	11 (68.8)	5 (31.3)	
20<	5 (23.8)	16 (76.2)	
Type of practice			
PhD student	9 (69.2)	4 (30.8)	0.002**
Private Practice	9 (42.9)	12 (57.1)	
Clinic-Hospital	8 (44.4)	10 (55.6)	
University	48 (81.4)	11 (18.6)	

Chi-square test ** $P < 0.01$, CBCT=Cone-beam computed tomography

quality of endodontic treatment and shortens the duration of root canal treatment procedures.^[1,9,16,17] Several digital radiographic systems are currently used in dental practice as an alternative to film-based radiography. In the last decade, both PSP and CCD or CMOS sensor systems have frequently been used by endodontists for intraoral examination. Recent improvements and continuing development of sensor technology have made higher-resolution images possible. Furthermore, algorithms offered by software systems enhance the image for various diagnostic purposes.^[11,12]

Several studies have evaluated the popularity of DRI since the adoption of digital radiology in dental offices. One study reported that 14% of dental practitioners chose using digital radiography,^[2] but subsequent studies reported a higher percentage.^[16,18] Surveys conducted amongst Belgian general dental practitioners reported that the rates of DRI use are of 34% (18% PSP, 16% CCD) and 38%.^[16,18]

Over the last few years, introduction and sales of digital systems in Turkey have increased. In a study conducted in Turkey in 2005, Ilgüy *et al.*,^[7] showed that DRI was used by 14% of dental clinicians.^[7] In a recent report from Dolekoglu *et al.*,^[6] it was noted that the rate of use of digital radiology as an aid has increased to 67%.^[6]

Previous reports focused on the use of DRI in different groups of general dentists, but none assessed endodontists, despite their frequent use of DRI. This fact should be kept in mind when comparing our results with previous reports. This study revealed that 76.6% of Turkish endodontists used DRI, indicating its popularity in this group. However, DRI use seemed to depend on the advances of dental faculties, since academics and PhD students in endodontics were

the main groups participating in the questionnaire. Of endodontists employed at the university, 91.5% indicated that they have used digital systems routinely, as did 84.6% of PhD students.

Similar to the findings of Brian and Williamson,^[5] “no developing process” (81.2%) was stated as the most important factor for choosing digital radiography, followed by being easy and rapid to maintain (78.8%).

Fifty percent of the NDUEs stated price to be the most important reason for not choosing DRI. This finding is in agreement with previous studies.^[2,5,6,19] In contrast to previous reports,^[2,6] significant differences were observed between the DUEs and NDUEs groups according to gender ($P < 0.005$), age ($P < 0.001$) and years of professional experience ($P < 0.001$).

As seen in this study, the most preferred digital imaging method was periapical radiography. However, 63.5% of the endodontists stated that DRI increased the number of exposures, which is in accordance with other recent reports.^[6,19,21]

Use of film holders is highly recommended, and the paralleling film-taking technique in endodontics is known to be superior to the bisecting angle technique.^[9,19] However, patient’s finger was still frequently used during film taking. The present study showed that 15.3% of the endodontists have used a film holder while taking digital images. This rate was lower than previous reports.^[21,22]

CBCT is a recent dental imaging modality, and compared to the patient radiation dose for maxillofacial imaging by CT (~2000 mSv), exposes the patient to 76.2% less radiation.^[23-28] Because of the field of view, the beam is limited to a smaller area, leading to a reduction in radiation dose.^[13,23-28] Of the endodontists, 66.7% stated that they had previous knowledge of CBCT. A correlation between age/experience and awareness of CBCT was observed ($P < 0.01$). The percentage of endodontists knowledge regarding CBCT was lower (26.1%) in endodontists over 40 years of age when compared with younger age groups ($P < 0.01$) and type of practice ($P < 0.01$). No statistically significant difference was found between male and female endodontists. Of all endodontists, 62.2% were aware of the difference between CT and CBCT regarding the radiation dose and 41.9% stated that they had referred their patients for CBCT. The main reasons for CBCT referrals were similar to those provided by general dentists.^[6,25]

Although 56.8% of the endodontists indicated that they had controls of their X-ray units, 43.2% ignored the need for routine service. In a survey in 2005, Ilguy *et al.*,^[7] reported that only 16.7% of Turkish general dental practitioners had their X-ray units serviced routinely. In a similar survey

in 2011, 47% of the respondents reported that they have periodic maintenance of radiographic equipment which was comparable to the 56.8% of our survey. Owing to the fact that our survey was amongst Endodontic Specialists, this increase in the percentage of practitioners having their X-ray units’ controlled was not surprising. Maintenance of the radiographic equipment is important for radiation safety; however, some endodontists did not seem to be concerned about the need for radiation protection.

Scientific meetings and congresses held by dental associations and universities helped promote further education for the benefit of practitioners. Internet was also noted as another source used by endodontists to update their knowledge.

In conclusion, this study clearly showed that the number of endodontists using digital imaging and knowledge of CBCT have been increasing in Turkey. Continuing education in dentomaxillofacial radiology has an important role in the transfer from analog to digital radiology. The findings of the present study highlighted the need for adapting to new technologies via continuing education.

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Questionnaire for the Digital Radiology and Cone Beam CT

1. Age:
2. Gender:
3. PhD Student Private Practitioner Clinic/ Hospital University Other.....
4. Country/City:
5. Years of professional experience
6. Do you use digital radiological imaging techniques in your practice?

Yes No

If your answer is "NO", please go to 14th question.

If your answer is "YES":

7. Please mark the reason(s) of using digital radiological techniques (Multiple responses are allowed)
 - Relatively lower radiation dose
 - Easy and fast to maintain
 - No developing process
 - No wastage due to developing process, so environment friendly
 - No artifacts due to developing process
 - Image settings and measurements are possible
 - Easy to store images
8. In the future, do you have any plans to use digital imaging techniques on a daily basis?
 - Yes No
9. Which kind of radiographic imaging technique do you use? (Multiple responses are allowed)
 - Panoramic
 - Periapical (Intraoral)
 - All
10. In which frequency do you use digital imaging techniques?
 - Never

- Rarely
 Sometimes
 Very frequently
 Always
- (If your answer is rarely/sometimes, for which procedure?)
11. The image quality of digital images is satisfactory
 Strongly disagree
 Disagree
 Neither agree nor disagree
 Agree
 Strongly agree
 12. Is the number of repetitions of film taking increased?
 Yes No
 13. Do you have any difficulty in placing digital sensors into mouth?
 Yes No Sometimes
 14. Do you use smaller sensors for pediatric patients?
 Yes No
 15. How old is your dental X-ray device?
 1-7 8-15 16-25 More than 25 years
 16. Do you have panoramic X-ray device in your clinic? Yes No
 If your answer is "Yes":
 17. Which of the following do you prefer?
 Film/Analog CCD/CMOS Phosphor Plate
 18. Do you use film holder when taking digital imaging?
 Yes No
 19. When compared with conventional radiography, do you set the exposure time shorter? Yes No
 20. How often do you have your X-ray unit controlled?
 Routinely Occasionally Never
 21. Which sensors do you use for digital imaging?
 CCD/CMOS
 Phosphor plate
 22. If you were to buy a new digital imaging system, which sensor would you have preferred?
 CCD/CMOS
 Phosphor plate

If your answer to the first question is "No";

23. Please check the reason(s) of not using digital imaging techniques (Multiple responses are allowed)
 Expensive
 Poor image quality
 I do not have essential equipments
 I do not know how to use computer
 Hard to perform
 I have no idea

24. Do you have any knowledge about Cone BeamCT/Digital Volumetric Tomography (DVT)?
 Yes No
 If your answer is "No", the questionnaire is ended. Thank you.
 If your answer is "YES";
25. Have you ever referred your patients to Cone Beam/Digital Volume Imaging?
 Yes No
26. 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

No idea

27. In which situation(s) do you prefer CBCT7DVT imaging? (Multiple responses are allowed)

Trauma

Cyst-tumor

To examine the morphology of root canal

To indicate the resorption area

To detect the exact place of broken files

Implant Planning

28. How do you update your knowledge for radiographic imaging?

Congress, exhibition

Conference and continuing education with credits

Books, Journals

Company representatives

Internet