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Evaluation of the use of cone-beam computed tomography by endodontic practitioners in Türkiye

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Purpose: The present study aimed to investigate the perspectives of endodontists and doctoral/residency students in Türkiye regarding the acceptance, accessibility, and usage of cone-beam computed tomography (CBCT) imaging.

Methods: An online survey was conducted, and members of the Turkish Endodontic Society were invited to participate. The survey comprised 15 questions, with the first six focusing on CBCT use and accessibility, as well as participants' demographics.

Results: Out of 178 respondents, 79.2% reported using CBCT in their clinical practice, with 69.1% having on-site access and 22.5% using off-site facilities. Faculty members showed the highest frequency of CBCT usage. CBCT was most commonly prescribed for cases involving internal/external root resorption and dental anomalies.

Conclusion: Based on the survey's results, it is suggested that CBCT scans should be used with a patient-centric approach, weighing the benefits against risks, and should be limited based on individual case requirements.

Keywords: Cone-beam computed tomography; dentistry; endodontics; endodontists; survey.

Introduction

Cone-beam computed tomography (CBCT) offers a three-dimensional radiographic assessment of teeth and their surrounding tissues, aiding in diagnosing and managing endodontic problems (1,2). CBCT imaging distinguishes odontogenic from non-odontogenic lesions and helps evaluate complex root canal anatomy, procedural iatrogenic complications, external and internal resorptive defects, or root fractures. Regarding the treatment planning process, the information gained from CBCT scans can influence the decision for surgical intervention, conventional retreatment, and even tooth extraction (3).

CBCT improves diagnostic accuracy by overcoming the limitations of conventional radiography, such as anatomical noise and geometric distortion. Nevertheless, it is crucial to balance the benefits of CBCT against its relatively higher radiation exposure risk compared to periapical ra-

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diographs. Artifacts caused by radiopaque materials can also hinder accurate diagnosis in CBCT imaging (4,5).

Endodontists worldwide are increasingly embracing CBCT, as reflected in guidelines from specialist associations (5,6). While intraoral radiographs are recommended for initial evaluation, CBCT becomes valuable in cases where data are inconclusive or inconsistent with clinical information, emphasizing its prudent use on a case-by-case basis.

Various survey studies have investigated why CBCT is preferred in clinical practice in different specialties, such as oral and maxillofacial surgery, orthodontics, and endodontics (7-9). A survey of members of the American Association of Endodontists (AAE) reported that CBCT is actively used for diagnosis and treatment planning in endodontic practice. The survey results revealed that there is still a gap in the acceptance of the usefulness of CBCT among clinicians due to radiation concerns. In contrast, some clinicians agree that CBCT technology can provide additional information not obtained from conventional radiography (9).

While the preferred CBCT device parameters and patient-

1. Your age group:
- ≤ 35
- 36-45
- 46-55
- ≥56

2. Your degree granted:
- Doctoral/residency students
- Endodontist
- Faculty member (Assistant Professor)
- Faculty member (Associate Professor)
- Faculty member (Professor)

3. Years since practicing in endodontics:
- <5 years
- 5-10 years
- 11-15 years
- 16-20 years
- >20 years

4. In which institution do you work?
- Oral and Dental Health Center
- University
- Other public institutions
- Private
- Other

5. Do you have access to Cone Beam Computed Tomography (CBCT) for your clinical practice?
- Yes, it is available at my institution/clinic
- Yes, it is not available at my institution/clinic. I refer to a different center (e.g. imaging center).
- None

6. Do you use CBCT in your clinical practice?
- Yes
- No

6.1. If yes,
6.1.1. Which field of view (FOV) size do you prefer?
- Limited (5 cm and smaller)
- Medium
- Single arch
- Large

6.1.2. How often do you use CBCT in the following situations (Select: never; rarely; occasionally; frequently; consistently)?
- Dentoalveolar trauma
- Suspected vertical root fracture in endodontically treated teeth
- Suspected vertical root fracture in non-endodontically treated teeth
- Endodontic treatment of teeth with dental anomalies
- Detection of perforations
- Extent of periapical lesion
- Localization of separated instrument in the root canal
- Assessment of healing
- Preoperatively for surgical retreatment
- Preoperatively for non-surgical retreatment
- Differential diagnosis
- External resorption
- Internal resorption
- Immature teeth
- Missing canals
- Calcified canals

6.1.3. How many patients do you utilize CBCT per month?
- ≤ 1
- 2-4
- ≥ 5

6.1.4. The % of your patients who refuse CBCT due to radiation concerns?
- ≤10%
- 11%-30%
- 31%-50%
- ≥51%

6.1.5. The % of your patients who refuse CBCT due to cost?
- ≤10%
- 11%-30%
- 31%-50%
- ≥51%

6.1.6. Which CBCT machine do you prefer to use?
- I don't know
- Doesn't matter, more than one
- Sirona
- Carestream
- J Morita
- Planmeca
- Other ……..

6.1.7. Are you satisfied with the resolution of the system you use?
- Not happy at all
- Moderately satisfied
- Satisfied
- Very pleased

6.1.8. How familiar are you with the program of the system you use?
- I am familiar with the program and I do all the review myself, via the CD or online.
- I only examine the sections sent by e-mail and utilize the evaluation of the imaging center.

6.1.9. How long have you been using CBCT in your clinical practice?
- <3 years
- 3-7 years
- ≥7 years

6.2. If no,
6.2.1. Why do you not prefer CBCT? (You can select more than one option)
- I have no access
- It costs too much
- I find it unnecessary
- I feel inadequate in interpreting CBCT images

Fig. 1. Online survey.

related factors are essential for the correct interpretation of CBCT images, the performance and experience of the observer in interpreting the images are equally important (10,11). Accordingly, professional organizations in different countries organize lectures, seminars, hands-on and face-to-face exercises, case-based discussions, and group training to enhance CBCT prescription and interpretation skills (12). This situation brings with it the need to reveal different needs and approaches on the basis of countries. In this context, it may be important to conduct research to evaluate the rationale behind endodontists' decisions in different countries regarding the prescription of CBCT imaging and to monitor changes in their decisions over time. Although there are studies on the use of CBCT in various countries and fields (7-9), there is a scarcity of research focusing on the opinions of endodontists in Türkiye. This study aims to reveal the approaches of the members of the Turkish Endodontic Society in Türkiye toward the acceptance, accessibility, and use of CBCT imaging through an online survey.

Materials and Methods

Following the Ethics Committee's approval (Istanbul Medipol University, dated 26.08.2022, no: E-10840098-772.02-4795), an online survey was conducted and e-mailed to members of the Turkish Endodontic Society (Fig. 1). The invitations were sent twice, with a 4–5-week interval between them. The survey was administered over a 3-month period between September 2022 and December 2022 in Türkiye. The email informed participants that the survey was part of a research project and assured them anonymity. The first six questions in the survey focused on CBCT use, accessibility, and participants' demographics, including age, gender, clinical experience, affiliation, and institution. Participants who did not use CBCT in their clinical practice were directed to explain their reasons, and the survey ended for them.

For those who preferred CBCT, the subsequent nine questions gathered additional details, such as the frequency of CBCT use for specific endodontic diagnoses and treatments, radiation and cost concerns, and CBCT parameters (FOV size, image resolution, type of CBCT machine, and experience with CBCT images). Participants were expected to answer all questions accordingly; they could only proceed if questions were answered. Except for two questions, only one option could be selected for the other questions. One of these two questions was for CBCT users, asking about the frequency (never, rarely, occasionally, frequently, and consistently) of use in different endodontic cases. The other question was for non-users, inquiring about the reasons for not using CBCT, with the option to select multiple reasons or provide their own views.

Statistical Analysis

After collecting the responses, statistical analysis was performed using the SPSS 19.0 software package (IBM Corp. Released 2010). The Kolmogorov–Smirnov test assessed the normal distribution of data. Descriptive analysis was presented as frequencies and percentages. Chi-square test was used to evaluate relationships between relevant factors and CBCT use. Type 1 error alpha was set as 0.05.

Results

One hundred and eighty participants responded to the survey, resulting in a response rate of approximately 22.5%. However, two of the survey participants were not included in the statistical analysis due to their contradictory answers (they declared that they both used and did not use). Around 69.7% of the participants had ten or fewer years of professional experience, and the majority (73%) were 35 years old or younger. While 44.9% of the participants were endodontists and doctoral/residency students, 69.1% were faculty members working at the university. The professional characteristics of the participants are shown in Table 1.

The majority of participants (79.2%) reported using CBCT regardless of access to CBCT (n = 141). A total of 163 participants had access to CBCT on-site or off-site. About 69.1% of the participants had the opportunity to use CBCT in the institution where they work (on-site),

Table 1. Professional characteristics of the participants (n=178)

Characteristics	n	%
Age group (years)		
≤35	130	73.0
36–45	27	15.2
46–55	14	7.9
≥56	7	3.9
Degree granted		
Doctoral/residency students	80	44.9
Endodontist	42	23.6
Assistant professor	26	14.6
Associate professor	9	5.1
Professor	21	11.8
Institution		
Oral health center (public)	7	3.9
Private clinic	48	27.0
University	123	69.1
Years since practicing in endodontics		
<5 years	65	36.5
5–10 years	59	33.1
11–15 years	19	10.7
16–20 years	15	8.4
>20 years	20	11.2

Table 2. Frequency of participants' CBCT use by indication (n=141)

Indication	Frequency				
	Never n (%)	Rarely n (%)	Occasionally n (%)	Frequently n (%)	Consistently n (%)
Calcified canals	24 (17.0)	74 (52.5)	29 (20.6)	10 (7.1)	4 (2.8)
Missing canals	15 (10.6)	47 (33.3)	52 (36.9)	22 (15.6)	5 (3.5)
Immature teeth	52 (36.9)	49 (34.8)	34 (24.1)	5 (3.5)	1 (0.7)
Internal resorption	7 (5.0)	30 (21.3)	31 (22.0)	48 (34.0)	25 (17.7)
External resorption	10 (7.1)	29 (20.6)	34 (24.1)	42 (29.8)	26 (18.4)
Differential diagnosis	12 (8.5)	33 (23.4)	44 (31.2)	39 (27.7)	13 (9.2)
Preoperatively for non-surgical retreatment	34 (24.1)	70 (49.6)	27 (19.1)	7 (5.0)	3 (2.1)
Preoperatively for surgical retreatment	24 (17.0)	52 (36.9)	25 (17.7)	24 (17.0)	16 (11.3)
Assessment of healing	42 (29.8)	63 (44.7)	27 (19.1)	7 (5.0)	2 (1.4)
Localization of separated instrument in the root canal	48 (34.0)	47 (33.3)	26 (18.4)	17 (12.1)	3 (2.1)
Extent of periapical lesion	16 (11.3)	53 (37.6)	43 (30.5)	22 (15.6)	7 (5.0)
Detection of perforations	18 (12.8)	46 (32.6)	45 (31.9)	23 (16.3)	9 (5.1)
Preoperatively for endodontic treatment of teeth with dental anomalies	14 (9.9)	31 (22.0)	35 (24.8)	35 (24.8)	26 (18.4)
Suspected vertical root fracture in non-endodontically treated teeth	21 (14.9)	43 (30.5)	38 (27.0)	24 (17.0)	15 (10.6)
Suspected vertical root fracture in endodontically treated teeth	23 (16.3)	43 (30.5)	35 (24.8)	25 (17.7)	15 (10.6)
Dentoalveolar trauma	11 (7.8)	42 (29.8)	35 (24.8)	38 (27.0)	15 (10.6)

and 22.5% at another center (off-site). About 87.8% of those who have a CBCT on-site and 80.0% of those who have access to CBCT off-site preferred to use CBCT in clinical practice ($p = 0.29$). The frequency of CBCT use was the highest for the faculty members ($p = 0.01$). No significant difference was found among doctoral/residency students, endodontists, and faculty members in terms of not using CBCT despite the accessibility of CBCT. In addition, working years and public/private sector status did not influence non-use ($p > 0.05$).

6.4% of CBCT users (n = 141) preferred large, 19.9% medium, 15.6% single arch, and 58.2% limited FOV. The frequency of CBCT use varied, with 46.8% prescribing it once or less, 44.7% 2–4 times, and 8.5% more than 5 times a month. The frequency of CBCT use according to the participants' indications is given in Table 2. According to the indications, Fig. 2 shows the relationship between CBCT use, on-site/off-site accessibility, and frequency of

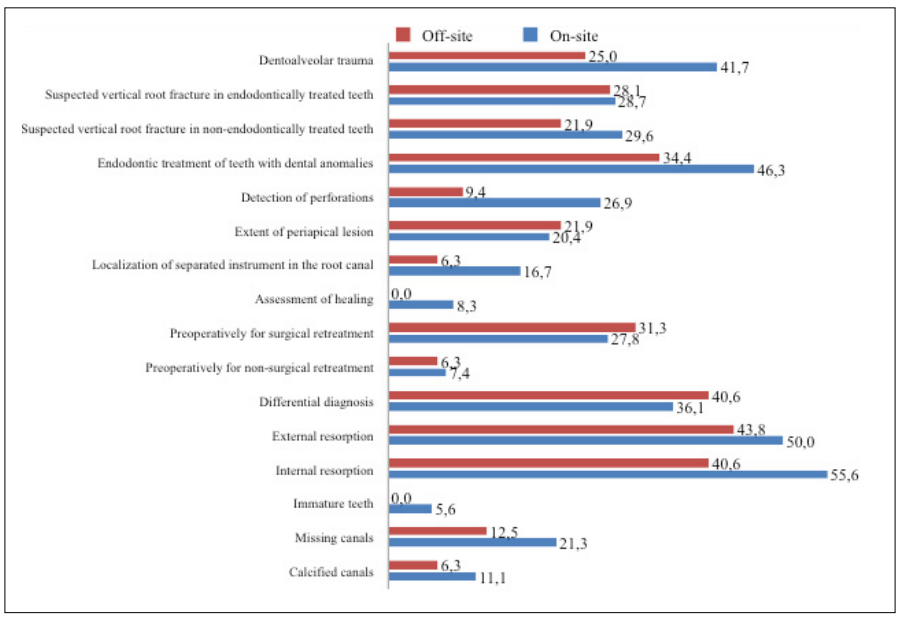

Fig. 2. Relationship between CBCT use, on-site/off-site accessibility, and frequency of use.

Table 3. The relationship between the professional characteristics and the CBCT usage status of the participants who have access to CBCT on-site or off-site (n=163) and also the program familiarity of the participants who use CBCT (n=141)

Characteristics	Access to CBCT (n=163)		
	Yes, I use CBCT n (%)	No, I do not use CBCT n (%)	p*
Degree granted			1-2: p= 0,72
Doctoral/residency students (1)	60 (82.2)	13 (17.8)	2-3: p= 0.03
Endodontist (2)	27 (77.1)	8 (22.9)	1-3: p= 0.01
Faculty member (3)	53 (96.4)	2 (3.6)	
Years since practicing in endodontics			0.91
<5 years	49 (83.1)	10 (16.9)	
5-10 years	41 (80.4)	40 (19.6)	
>10 years	50 (94.3)	3 (5.7)	
Institution			1.00
Public	102 (85.7)	17 (14.3)	
Private	38 (86.4)	6 (13.6)	
Characteristics	**Familiarity with the program for evaluation of CBCT scans (n=141)**		
	Practitioner self-evaluation of CBCT scans n (%)	Referral to an oral and maxillofacial radiologist n (%)	p
Degree granted			0.47
Doctoral/residency students	40 (65.6)	21 (34.4)	
Endodontist	20 (74.1)	7 (25.9)	
Faculty member	40 (75.5)	13 (24.5)	
Years since practicing in endodontics			0.06
<5 years	29 (59.2)	20 (40.8)	
5–10 years	34 (81.0)	8 (19.0)	
>10 years	37 (74.0)	13 (26.0)	
Institution			0.29
Public	70 (68.0)	33 (32.0)	
Private	30 (78.9)	8 (21.1)	

*Significance was taken as 0.05 in the Chi-square test. In case of difference between the three groups, pairwise comparisons were evaluated with Bonferonni correction and the significance was taken as p=0.016.

use. No significant difference was found between those who "consistently" and "often" prefer to use CBCT and less frequently, with on-site and off-site CBCT access for all indications.

According to the clinicians' responses, the rate of refusing CBCT imaging was less than 10% in 94.3% of patients due to radiation exposure and 67.4% due to cost concerns.

About 70.9% of CBCT users were familiar with the program and self-evaluated CBCT scans, unaffected by factors such as title, working years, and institution (Table 3). Among CBCT users, 6.4% were unsatisfied with the resolution, 50.4% were moderately satisfied, 36.9% were satisfied, and 6.3% were very satisfied. Nearly half (50.4%) of CBCT users have been using it for <3 years, 31.9% for 3–7 years, and 17.7% for more than 7 years.

Table 4. Reasons for not prescribing CBCT

Reasons	n
No CBCT access	28
Not familiar with CBCT scans	28
Cost	17
Not necessary to use CBCT	8
Low resolution and image quality of CBCT scans	2
Not prefer to use it routinely	2
Workload	1

Participants could select multiple options for not preferring the use of CBCT. Accordingly, the most common reasons included the clinician's lack of access to CBCT and a lack of self-efficacy in CBCT evaluation, as shown in Table 4.

Discussion

The present survey assessed current approaches regarding the acceptance, accessibility, and use of CBCT among endodontic practitioners in Türkiye. For this purpose, a software-based survey was conducted and distributed to endodontists and doctoral/residency students in this field. In 2017, Setzer et al. (9) used a similar approach to investigate CBCT usage among endodontic practitioners in the United States. The overall response rate was reported as 35.2%. The present survey included similar questions to determine whether CBCT usage preferences differ by country. Because the application of CBCT prescription guidelines may differ between countries, revealing these differences allows an understanding of what factors may affect the applicability of these guidelines (13). Although the present survey achieved a lower response rate than the aforementioned study, it can be considered acceptable, considering similar response rates in other endodontics surveys (14,15). Furthermore, as stated in the same study, the phenomenon of "survey fatigue," where participants lack motivation to answer electronic surveys, may account for the low response rate (9).

The present survey revealed that most participants (69.1%) used CBCT, and 69.1% had on-site access to CBCT at their institutions. Although similar usage rates were observed compared to Setzer et al.'s study [9], higher access opportunity rates were found in the present survey. This difference may be related to the facilities of the participants' institutions and the execution of the studies in different periods. As the case-specific benefits of using CBCT become evident over time, the number of institutions with CBCT devices may have increased. The fact that most of the participants in the present survey were faculty members and the faculty members prescribed more CBCT than the other participants could support this hypothesis.

A small FOV scan reduces the volume of the exposed tissue and, therefore, the scattering, which improves the effective radiation dose and image quality. For these reasons, small FOV CBCT scans are often sufficient and recommended for diagnosing and managing endodontic problems (3). In the present survey, participants indicated that they mostly preferred the limited FOV and the least significant FOV, proving that they followed this recommendation.

Regarding the frequency of CBCT prescription, most participants (46.8%) prescribed CBCT once a month or less, with only 8.5% prescribing it more than 5 times a month. Unlike our findings, a recent study evaluated the factors that predict the use of CBCT among endodontists in Australia and New Zealand, reported that most participants (44%) prescribed up to ten CBCT scans per month. Differences in these frequencies may be due to case-by-case variables or clinicians' preferences. The AAE recommends limiting the use of CBCT imaging to the specific situations listed in the joint position statement (6). In a study evaluating the basis for CBCT recommendations, it was suggested that although CBCT imaging is included in the AAE recommendations, most faculty members did not prefer CBCT based on their experience in cases such as non-surgical retreatment that allow them to use existing conventional 2D radiographs. Other common reasons for not using CBCT imaging were reported as increased treatment cost and prolonged procedure time, especially when CBCT scanning was recommended mid-treatment (16). According to the findings of the present survey, participants using CBCT stated that they applied to CBCT more frequently in the presence of internal/external root resorption and before endodontic treatment of teeth with dental anomalies. They stated that they used CBCT less frequently or did not apply it to evaluate healing and immature teeth. Moreover, it was observed that taking CBCT on-site or off-side did not affect the frequency of preferring CBCT on a case-by-case basis.

In the case of a CBCT prescription, patients' concerns about cost outweighed their concerns about radiation exposure. While 67.4% of the participants reported that <10% of their patients refused a CBCT prescription due to cost, the same percentage of rejection was found in 94.3% regarding radiation exposure. This finding can be associated with many factors, such as patients' socioeconomic levels, the public or private institution/clinic that the patients visit for endodontic treatment, and patients' health insurance coverage. In a study evaluating the perceptions of patients in the military population regarding the application of CBCT imaging for endodontic treatment, it was reported that misconceptions about radiation exposure existed among many patients, with 50% of patients overestimating the actual radiation doses associated with CBCT scans. The lack of a patient financial burden associated with dental procedures in the military dental system has been cited as a limitation, suggesting that this factor may affect the patient's willingness to seek an endodontic provider with CBCT technology if CBCT incurs extra cost (17).

Regardless of title, year of employment, and institution, 70.9% of participants self-evaluated CBCT scans rather than referral to an oral and maxillofacial radiologist. Moreover, among participants, about half of CBCT users had been prescribing it for <3 years. Similarly, Seltzer's study (9) noted that survey respondents needed more concern in interpreting CBCT images, and only one participant commented that radiologists needed an expert

interpretation of CBCT images, significantly if the area extended beyond the teeth. This may be because, with the widespread use of CBCT in dentistry, even dental undergraduate students are becoming more familiar with and experience interpreting CBCT images (18). However, it should be accepted that undergraduate education may differ based on faculties and post-graduate education is mainly related to the individual's own efforts. In the present study, the slight majority who did not prescribe CBCT cited the reasons for this as their lack of self-efficacy and access to CBCT. Rabiee et al.'s study (19) suggested that as a result of the understanding that CBCT has a place in endodontics in the future, the confidence and knowledge of endodontists in interpreting CBCT images will increase by expanding educational efforts, especially in endodontic residency programs.

Due to the limited availability of literature on the utilization CBCT by Endodontists in Türkiye, making comparisons across different time periods is challenging. However, a study assessed the knowledge and attitudes of Turkish endodontists regarding digital radiological imaging and CBCT (20). This study, which had a smaller participant pool compared to the present study, reported that 66.7% of endodontists had knowledge about CBCT, with 41.9% of them referring their patients for CBCT scans. When compared to the rate of CBCT utilization among participants in the present study, this rate showed an increase over time. Furthermore, the reasons for referring patients for CBCT scans included conditions such as cysts, tumors, implant planning, trauma assessment, resorption analysis, examination of root canal morphology, and precise localization of broken files. Notably, these indications are not exclusive to endodontic practice. In this context, it can be inferred that CBCT has seen broader adoption within the field of endodontics over the years.

While the level of participation in the present study was generally acceptable for this type of research, a significant proportion of potential participants did not engage. Non-response may be attributable to factors such as lack of interest in CBCT imaging, perceived overlong length of the survey, or simple reluctance to participate. This could potentially lead to an overrepresentation of certain preferences in terms of CBCT usage. Another limitation to consider is the representativeness of our participant sample. It is important to acknowledge that not all endodontists in Türkiye may be members of the Turkish Endodontic Society and, therefore, might not have had access to the survey link.

Conclusion

This survey demonstrated that participants widely applied CBCT for various endodontic diagnostic and therapeutic applications. Considering that the benefit-risk ratio of CBCT scans should always favor the patient, it was found that the participants determined the CBCT-taking parameters in line with the recommendations and limited their frequency/indications for use on a case-by-case basis. In this context, CBCT was found to be mainly prescribed for internal/external root resorption and before endodontic treatment of teeth with dental anomalies.

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