

Knowledge and Attitude of Iraqi Dentists towards the Use of Cone Beam Computed Tomography in Endodontics: A Questionnaire Study

Nassr Al-Nuaimi^{1,2}, Anas F. Mahdee², Raghad Al-Hashimi^{1,2}, Francesco Mannocci¹

ABSTRACT

Objective: The aim of this study was to assess the knowledge and attitude of Iraqi dentists towards cone beam computed tomography (CBCT) applications in endodontics by using an online survey.

Materials and Methods: A questionnaire, consisting of 31 questions, targeted general dental practitioners and specialists in different dental specialities. A total of 306 participants were included. Data were assessed according to the frequency of distribution and the chi-square test was applied to analyse the difference in responses between two independent groups.

Results: Among the participants 63.4% were using digital radiography in their daily practice, and 84% had awareness about CBCT's uses, with higher statistically significant responses among endodontists. About 51.4% of participants gained their CBCT knowledge from lectures, while 79.4% believed that continuous education courses enhance knowledge of CBCT. Nearly 75% of participants agreed on the accuracy of CBCT rather than periapical radiography in detecting endodontic conditions. However, most participants responded that CBCT would be used selectively in their future routine practice.

Conclusions: This questionnaire showed that Iraqi dentists have a very good knowledge regarding indications and limitations of CBCT in endodontics. However, there is a lack of structured teaching and practical training on the use of CBCT within dental schools. The development of CBCT training programmes and increasing the availability of CBCT machines within dental schools are strongly supported by the results of this survey.

KEY WORDS

cone beam computed tomography, endodontics, knowledge, questionnaire

INTRODUCTION

Intraoral periapical radiography (PA) is an essential component in the diagnosis and management of dental pathology and has always played an integral part in Endodontics. However, PA has inherent limitations¹. Meanwhile, cone beam computed tomography (CBCT) is a novel three-dimensional imaging system for the dental and maxillofacial region that overcomes all of the limitations of PA and has become commonly used in a wide range of clinical applications¹.

Several studies have assessed the application of CBCT in different fields of dentistry, including its use in orthodontics², oral and maxillofacial surgery³, and in implant dentistry⁴. In Endodontics, the use of CBCT in the diagnosis, decision making, treatment planning and/or management of endodontic problems is rapidly increasing worldwide¹ and international guidelines have been developed by the American Association of Endodontists (AAE)/American Academy of Oral and Maxillofacial Radiology (AAOMR)⁵ and the European Society of Endodontology (ESE)⁶ to clarify its indications and contra-indications in endodontics.

Therefore, since CBCT imaging is relatively new in Iraq, this study was designed to assess the knowledge and attitude of dentists in Iraq towards CBCT applications in Endodontics by means of an online survey.

MATERIALS AND METHODS

The questionnaire was designed with the guidance of similar studies⁷⁻¹⁰ and reviewed by five Endodontists, experts in using CBCT in Endodontic therapy.

The questionnaire targeted general dental practitioners (GDPs) and specialists in different dental specialties registered within the Iraqi Dental Association (IDA) and practicing in Iraq. The sample size required was calculated based on a previous electronic questionnaire study¹¹ that targeted Iraqi dentists and depended on the total of registered dentists in IDA in 2020 which was 6,463. The sample size was calculated according to the following formula¹²:

Sample size = (distribution of 50%)/[(margin of error%/ confidence level score)²]

Confidence level = 1.96

Margin of error = 0.05

The true sample size determined within this study was 306 dentists.

The online questionnaire (Google Form) included 31 questions divided into five sections:

Section 1, (Q.1 to 5), included demographic questions on the participants' age, gender, academic qualification, specialty, and experience.

Section 2, (Q.6 to 8), focused on participants' knowledge about the

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1) Centre for Oral, Clinical & Translational Sciences, King's College London Dental Institute
London, UK

2) Department of Restorative & Aesthetic Dentistry, College of Dentistry, University of Baghdad
Baghdad, Iraq

Correspondence to: Nassr Al-Nuaimi
(e-mail: nassr.alnuaimi@gmail.com)

Table 1: Demographic characteristics of the survey participants

Characteristics	No. (%)
1. Gender	
Male	148 (48.4%)
Female	158 (51.6%)
2. Age	
Less than 30	137 (44.8%)
30-35 years	76 (24.8%)
36-40 years	40 (13.1%)
Over 40 years	53 (17.3%)
3. Years of clinical experience	
Less than 5 years	121 (39.5%)
5-9 years	77 (25.2%)
10-15 years	49 (16%)
Over 15 years	59 (19.3%)
4. Qualification	
BDS	142 (46.4%)
Postgraduate Diploma	25 (8.2%)
MSc	102 (33.3%)
PhD	37 (12.1%)
5. Specialisation	
General dental practitioners	142 (46.4%)
Endodontists	46 (15%)
Pedodontists	29 (9.5%)
Oral & Maxillofacial surgeon	22 (7.2%)
Orthodontists	20 (6.5%)
Prosthodontists	16 (5.2%)
Oral pathologist	12 (3.9%)
Periodontists	11 (3.6%)
Oral and maxillofacial radiologists	6 (2%)
Laser dentistry specialists	2 (0.7%)

digital dental imaging.

Sections 3, (Q.9 to 17), was designed to address the awareness of participants of CBCT and the source of their knowledge.

Sections 4, (Q.18 to 29), evaluated participants' knowledge of CBCT applications in endodontics and its limitations.

Sections 5, (Q.30 and 31), investigated the expectations of the participants on the use of CBCT in the dental practice in the future.

The survey was carried out from November to December 2020. Ethical approval was granted by the Ethical Committee of the University of Baghdad College of Dentistry (Reference no.: 202520).

Descriptive statistics expressed by mean, standard deviation, and frequency/percentage were used to define the characteristics of the study variables. A Chi-square/Fisher's exact test was used to determine the relationship between categorical variables. The level of significance was set at $P < 0.05$. Statistical analyses were carried out using IBM SPSS software (Version 27; IBM, New York, NY, USA).

RESULTS

A total of 306 (4.7%) of the 6463 dentists registered in IDA Iraq participated in this study. Among the participants, 148 (48.4%) were males and 158 (51.6%) were females. The mean age of the participants was 32.75 ± 7.82 (24-61 years) and they had between 1 and 35 (8.76 ± 7.47) years of clinical experience. Regarding the participants' education level, 142 (46.4%) were bachelors in Dental Surgery, 25 (8.2%) had postgraduate diplomas, 102 (33.3%) Master degree, and 37 (12.1%) PhD degree. Among the specialists, there were representatives from almost all specialties in the dental field (Table 1).

Approximately 63.4% of the dentists used digital imaging modalities in their practice to make radiographs. The main reason for that was the practicality of storage and retrieval of the images ($n = 156$, 80.4%). Among the dentists who did not use digital radiographs, 86 (76.8%) saw digital radiographs as too expensive (Table 2).

Types of imaging modalities available in the dental practice of the responders were traditional film X-rays ($n = 183$, 59.8%), followed by digital Xray ($n = 157$, 51.3%), OPG ($n = 12$, 3.9%); only 38 (12.4%) of the responders had a CBCT machine in their practice. More than half (52.9%) of participants were satisfied with the image quality of the available digital imaging modalities (Table 2).

In section 2, there were significant differences in the responses between specialists in general ($P = 0.009$, $P = 0.027$)/endodontists ($P = 0.001$, $P = 0.002$) and GDPs in the use of digital modalities to make radiographs (Q.6) and the kind of imaging modalities available in dental practice (Q.7), respectively.

Of all the participants, 257 (84%) had awareness about uses of CBCT in dentistry. Almost half (51.4%) of the dentists had learned about CBCT from lectures (Table 3).

When the dentists were asked if they thought that adequate teaching was being given regarding CBCT to dental undergraduate students in dental schools, 40.2% (123) of the dentists were neutral and 29.4% (90) disagreed. In addition, 34% (104) of the participants agreed that information on CBCT should be taught in the 5th year of BDS, and 31% (90) suggested the 3rd year (Table 3).

Of the 306 participants, 79.4% (243) believed that frequent continuing education lectures/workshop should be conducted to enhance knowledge of CBCT. While 182 (59.5%) dentists expressed willingness to attend courses pertaining to CBCT, 208 (68%) dentists had not attended any such courses.

The majority of the participants ($n = 301$, 98.4%) thought that CBCT was a useful diagnostic tool in dentistry, and 288 (94.1%) felt the necessity of having a CBCT unit available in any dental institution. A high percentage, 78.1% (239) of respondents, had referred their patients for CBCT. The most frequent reason for this referral was the assessment of impacted teeth (48.5%), followed by implant planning (43.5%), cyst or tumor assessment (36.4%), and for endodontic assessment (33.5%). Endodontists seemed to be using CBCT for assessment of endodontic cases more often than GDPs and specialists of other branches (Table 3).

In section 3, statistically significant differences were noticed in the endodontists responses in comparison to GDPs' about their awareness toward uses of CBCT in dentistry (Q.9, $P = 0.044$), how they had obtained information about CBCT (Q.9a, $P = 0.025$), the adequacy of teaching given to the dental undergraduate students regarding CBCT by the faculty (Q.10, $P = 0.037$), attending courses related to CBCT (Q.13, $P < 0.001$), and the reasons for referring patients for CBCT examination (Q.16a, $P = 0.031$). The responses of all specialists ($P = 0.006$) and endodontists ($P = 0.031$) on referring patients for CBCT (Q.16) differed from those of GDPs. Specialists were also significantly more willing to attend courses related to CBCT compared to GDPs (Q.14, $P = 0.014$).

Among the study population, 229 (74.9%) agreed that CBCT imaging has been found to affect decision making in endodontics significantly (Q.18), whereas 54 (17.6%) of them neither agreed or disagreed on this.

Around 65.4% (200) of the participants agreed that CBCT has the ability to detect periapical pathosis better than 2D radiographs (Q.19), while 93 (30.4%) participants were unaware of this.

When CBCT imaging was compared with conventional periapical radiography (PA), 128 (41.8%) of the participants opined that the CBCT imaging detected more teeth with periapical lesions in comparison to conventional PA (Q.20), while 167 (54.6%) participants were unaware about it.

Regarding vertical root fracture (Q.21), 225 (73.5%) of the dentists agreed that CBCT scanning is recommended to identify the potential presence of a vertical root fracture, whereas 52 (17%) dentists were unaware of that. Additionally, 174 (56.9%) dentists thought that CBCT imaging is more effective in quantifying the extent of cracks in teeth compared with PA (Q.22), while 89 (29.1%) dentists were unaware of that.

Regarding endodontic microsurgery, 230 (75.2%) dentists reported that CBCT imaging evaluates periapical lesions and healing after endodontic microsurgery more precisely than PA (Q.23).

About 76.5% ($n = 234$) of the dentists felt that CBCT scans can help to locate second mesio-buccal canals in maxillary molars (Q.24), while 58 (19%) dentists disagreed. The ability of CBCT to detect missed or calcified canals and complex morphology (Q.25) was supported by 243 (79.4%) dentists, whereas 50 (16.3%) dentists disagreed.

Regarding the use of CBCT in diagnosing root resorption (Q.26), 240 (78.4%) dentists agreed that CBCT imaging was indicated to increase accuracy in diagnosing root resorption (Table 4). Meanwhile, 235 (76.8%) participants agreed that CBCT should not be used routinely for endodontic diagnosis or for screening purposes in the absence of clinical signs and symptoms (Q.27).

For most endodontic applications, the limited (small) field of view CBCT (Q.28) was preferred by 164 (53.6%) dentists over a medium or

Table 2: Participants' knowledge of digital dental imaging

Question	Response	Speciality				Total (n = 306)
		GDPs (n = 142)	Overall specialists (n = 164)	Endodontists (n = 46)	Other specialities (n = 118)	
6. Do you use digital imaging modalities to make radiographs?	Yes	79 (55.6%)	115 (70.1%)	38 (82.6%)	77 (65.3%)	194 (63.4%)
	No	63 (44.4%)	49 (29.9%)	8 (17.4%)	41 (34.7%)	112 (36.6%)
6.a. If yes, reasons for using digital imaging techniques	Easy and fast to maintain	64 (81%)	92 (80%)	33 (86.8%)	59 (76.6%)	156 (80.4%)
	Relatively less radiation dose	47 (59.5%)	89 (77.4%)	34 (89.5%)	55 (71.4%)	136 (70.1%)
	No developing required	47 (59.5%)	79 (68.7%)	32 (84.2%)	47 (61%)	126 (65%)
	Allow adjustments & measurements	47 (59.5%)	75 (65.2%)	28 (73.7%)	47 (61%)	122 (62.9%)
	Easy archiving of films	47 (59.5%)	72 (62.6%)	27 (71.1%)	45 (58.4%)	119 (61.3%)
	Less artefacts	35 (44.3%)	53 (46.1%)	24 (63.2%)	29 (37.7%)	88 (45.4%)
	Others	6 (7.6%)	5 (4.2%)	4 (10.5%)	1 (1.3%)	11 (5.7%)
6.b. If no, reasons for not using digital imaging/CBCT in your dental practice?	Expensive	47 (74.6%)	39 (79.6%)	8 (100%)	31 (75.6%)	86 (76.8%)
	No idea	10 (15.9%)	6 (12.2%)	0	6 (14.6%)	16 (14.3%)
	Lack of knowledge	9 (14.3%)	5 (10.2%)	0	5 (12.2%)	14 (12.5%)
7. What kind of imaging modalities are available in your dental practice?	Hard to perform	5 (7.9%)	2 (4.1%)	0	2 (4.9%)	7 (6.3%)
	Film Xray	95 (66.9%)	88 (53.7%)	17 (37%)	71 (60.2%)	183 (59.8%)
	Digital Xray	62 (43.7%)	95 (57.9%)	34 (74%)	61 (51.7%)	157 (51.3%)
	OPG	3 (2.1%)	9 (5.9%)	2 (4.3%)	7 (5.9%)	12 (3.9%)
	CBCT	11 (7.7%)	27 (16.5%)	9 (19.7%)	18 (15.3%)	38 (12.4%)
8. Are you satisfied with the image quality in the digital imaging modality available to you?	Not available	6 (4.2%)	0	0	0	6 (2%)
	Strongly agree	27 (19%)	41 (25%)	13 (28.3%)	28 (23.7%)	68 (22.2%)
	Agree	72 (50.7%)	90 (54.9%)	27 (58.7%)	63 (53.4%)	162 (52.9%)
	Neutral	41 (28.9%)	32 (18.3%)	6 (13%)	26 (22%)	73 (23.9%)
	Disagree	2 (1.4%)	1 (0.6%)	0	1 (0.85%)	3 (1%)
	Strongly disagree	0	0	0	0	0 (0%)

GDPs: General dental practitioners

large field of view CBCT, whereas 126 (41.2%) did not have an opinion on this.

Regarding the limitations of CBCT (Q.29), the highest percentage among dentists (63.4%, n = 194) responded that the high radiation dose is the most common limitation for CBCT usage, while potential for artefact generation, cited by only 6.5% (n = 20), was the least common limitation (Table 4).

In section 4 questions, endodontists were more often in agreement than other specialists and GDPs that CBCT could affect decision making in endodontics (Q.18, $P = 0.046$) and that CBCT had the ability to detect missed or calcified canals and complex morphology (Q.26, $P = 0.028$).

Regarding the future use of CBCT in routine dental practice, the majority, 180 participants (58.8%), felt that CBCT will be used selectively in dental applications (Q.30), while only 70 (22.9%) felt that CBCT will be used within all specialties (Table 5). Moreover, 178 (58.2%) dentists would choose to use CBCT in their future professional career (Q.31), 120 (39.2%) of them were unsure and the rest (n = 8, 2.6%) would not be willing to use CBCT in their future work.

Furthermore, when the participants were asked about cases in which they would prefer to use CBCT in future clinical life (Q.31a), 104 (37.5%) mentioned implants planning, 57 (20.6%) endodontics, and 26 (9.4%) evaluation of patients with cysts and tumors (Table 5).

In section 5, the endodontists responses were significantly different from those of GDPs regarding their choices on using CBCT in their future professional career (Q.31, $P = 0.005$) and the cases in which they would prefer to use CBCT (Q.31a, $P < 0.001$).

DISCUSSION

This cross-sectional study identified a high level of awareness among Iraqi dentists of digital radiography in general and CBCT specifically, with acceptable understanding about CBCT's role, applications, and limitations in endodontics; in addition to a good expectation of the extended use of CBCT in different specialties in future. These findings are understandable given that CBCT has recently become an essential tool for diagnosis and treatment planning in different specialties of den-

tistry worldwide. Similarly, several studies have been done to evaluate the knowledge and attitude towards digital radiography and CBCT among dental students¹⁰, general dentists^{7-9,13,14}, and endodontists^{15,16}. However, this is the first online survey to tackle these concepts among Iraqi dentists with different qualifications, including GDPs (142, 45.4%), dentists with postgraduate diplomas (25, 8.2%), masters (102, 33.3%) and PhD (37, 12.1%) degrees.

An interesting finding of the current study was that about two thirds of the participants had used digital radiography in their routine practice, describing it as an easy and fast method to make radiographs. Whereas those who were not using digital radiographs were mainly deterred by the high costs involved. Similarly, several earlier studies found that high cost was the main reason given by dentists for not using digital radiography^{17,18}.

Although more than three quarters of the participants were satisfied with the imaging quality of the available digital modalities, only 38 (12.4%) of the dentists had a CBCT machine in their practice. Meanwhile, surveys conducted in different Asian¹³ and American¹⁶ countries reported a much larger availability of in-house CBCT machines. This may be due to the weakness in the general medical/dental foundations in Iraq after four decades of military conflicts¹⁹. Overall, specialists and endodontists are using digital imaging modalities significantly more than GDPs according to the results of the present study.

Although CBCT is a recent 3D imaging modality in Iraq, the current study concluded that 84% of participants were aware of the usage of CBCT in dentistry, which was a similar finding to a study by⁷ and higher than in the studies by⁹ and¹⁸ who found that only 42.5% and 56% of their respondent dentists, respectively, had awareness about this field. Similarly, the level of this knowledge was very high (93.5%) among the current study's endodontists, in comparison to a study done by¹⁵ on Turkish endodontists.

In the present study, almost half (51.4%) of the dentists had learned about CBCT through lectures. This outcome was in disagreement with two other studies^{7,14} in which the primary sources of CBCT knowledge were postgraduate training or seminars/workshops. This difference could be due to the differences in the education syllabus among different schools of dentistry. Meanwhile, the other half of the current study's participants were either neutral or disagreed on the adequacy of teaching of CBCT in their undergraduate courses. This result is comparable with

Table 3: Participants' awareness and attitude towards cone beam computed tomography (CBCT)

Question	Response	Specialty				Total (n = 306)
		GDPs (n = 142)	Overall specialists (n = 164)	Endodontists (n = 46)	Other specialties (n = 118)	
9. Are you aware of CBCT's uses in Dentistry?	Yes	115 (81%)	142 (86.6%)	43 (93.5%)	99 (83.9%)	257 (84%)
	No	27 (19%)	22 (13.4%)	3 (6.5%)	19 (16.1%)	49 (16%)
9.a. If yes, how did you get information about CBCT?	Lectures	65 (56.5%)	67 (47.2%)	20 (46.5%)	47 (47.5%)	132 (51.4%)
	Internet	26 (22.6%)	37 (26%)	7 (16.3%)	30 (30.3%)	63 (24.5%)
	Seminars	12 (10.4%)	24 (16.9%)	13 (30.2%)	11 (11.1%)	36 (14%)
	Workshops	12 (10.4%)	14 (9.9%)	3 (7%)	11 (11.1%)	26 (10.1%)
10. Is adequate teaching given to the dental undergraduate students regarding CBCT by the faculty?	Strongly agree	4 (2.8%)	3 (1.8%)	0	3 (2.5%)	7 (2.3%)
	Agree	20 (14.1%)	30 (18.3%)	7 (15.2%)	23 (19.5%)	50 (16.3%)
	Neutral	57 (40.1%)	66 (40.2%)	20 (43.5%)	46 (39%)	123 (40.2%)
	Disagree	43 (30.3%)	47 (28.7%)	9 (19.6%)	38 (32.2%)	90 (29.4%)
	Strongly disagree	8 (5.6%)	18 (11%)	10 (21.7%)	8 (6.8%)	36 (11.8%)
11. In your opinion, in which year of dental education should CBCT be included?	III-year BDS	38 (26.8%)	59 (36%)	13 (28.3%)	46 (39%)	97 (31.7%)
	IV-year BDS	36 (25.4%)	38 (23.2%)	13 (28.3%)	25 (21.2%)	74 (24.2%)
	V-year BDS	54 (38%)	50 (30.5%)	13 (28.3%)	37 (31.4%)	104 (34%)
	Post-graduation	14 (9.9%)	16 (9.8%)	7 (15.2%)	9 (7.6%)	30 (9.8%)
	Not required	0	1 (0.6%)	0	1 (0.85%)	1 (0.3%)
12. Do you feel frequent continuing education lectures/workshops should be conducted to enhance your knowledge on CBCT?	Yes	111 (78.2%)	132 (80.5%)	37 (80.4%)	95 (80.5%)	243 (79.4%)
	No	2 (1.4%)	6 (3.7%)	3 (6.5%)	3 (2.5%)	8 (2.6%)
	Maybe	29 (20.4%)	26 (15.9%)	6 (13.1%)	20 (17%)	55 (18%)
13. Have you attended any courses related to CBCT?	Yes	40 (28.2%)	58 (35.4%)	23 (50%)	35 (29.7%)	98 (32%)
	No	102 (71.8%)	106 (64.6%)	23 (50%)	83 (70.3%)	208 (68%)
14. Are you willing to attend courses pertaining to CBCT?	Yes	72 (50.7%)	110 (67.1%)	30 (65.2%)	80 (76.8%)	182 (59.5%)
	No	10 (7%)	8 (4.9%)	3 (6.5%)	5 (4.2%)	18 (5.9%)
	Maybe	60 (42.3%)	46 (28%)	13 (28.3%)	33 (28%)	106 (34.6%)
15. Do you feel CBCT is a useful diagnostic tool in dentistry?	Yes	138 (97.2%)	163 (99.4%)	46 (100%)	117 (99.2%)	301 (98.4%)
	No	4 (2.8%)	1 (0.6%)	0	1 (0.8%)	5 (1.6%)
16. Have you ever referred your patients for CBCT imaging?	Yes	101 (71.1%)	138 (84.1%)	40 (87%)	98 (83.1%)	239 (78.1%)
	No	41 (28.9%)	26 (15.9%)	6 (13%)	20 (16.9%)	67 (21.9%)
16.a. If yes, in what cases have you referred your patients to CBCT?	Impacted teeth	53 (37.3%)	63 (38.4%)	9 (22.5%)	54 (55.1%)	116 (48.5%)
	Implant planning	38 (26.6%)	66 (40.2%)	12 (30%)	54 (55.1%)	104 (43.5%)
	Cyst or tumor	31 (21.8%)	56 (34.1%)	15 (37.5%)	41 (41.8%)	87 (36.4%)
	Endodontic evaluation	31 (21.8%)	49 (29.9%)	30 (75%)	19 (19.4%)	80 (33.5%)
	Trauma cases	14 (9.9%)	37 (22.6%)	11 (27.5%)	26 (26.5%)	51 (21.3%)
	Orthodontic assessment	19 (13.4%)	30 (18.3%)	2 (5%)	28 (28.6%)	49 (20.5%)
	All of the above	17 (12%)	16 (9.8%)	3 (7.5%)	13 (13.3%)	33 (13.8%)
17. Do you feel the necessity of having a CBCT unit at dental colleges?	Yes	131 (92.3%)	157 (95.7%)	44 (95.7%)	113 (95.8%)	288 (94.1%)
	No	11 (7.7%)	7 (4.3%)	2 (4.3%)	5 (4.2%)	18 (5.9%)

a study done by Kamburoğlu *et al.* in 2011.

At the same time, about one third of the participants in this study agreed that information on CBCT should be taught in the 5th year of BDS. The findings were similar to those provided by previous reports^{8,9,14}. They reported that lectures on CBCT should be incorporated in the clinical years of BDS. However, most of the participants believed that frequent continuing education lectures/workshops about the basic aspects of CBCT should be conducted to enhance their information regarding CBCT, which was similar to the finding by⁷. In this regard, 182 (59.5%) participants were interested in joining courses pertaining to CBCT.

The majority of the dentists thought that CBCT is a useful diagnostic tool in dentistry, and affirmed the necessity of having CBCT units in all dental institutions. The unavailability of CBCT at dental institutions played a significant role in limiting the provision of CBCT information in lectures. These findings are in accordance with previous studies^{7,9} conducted in India.

The responses to the questions on the participants' awareness and sources of CBCT teaching confirmed a lack information among GDPs. This finding highlighted the need for proper training about CBCT in the dental curriculum.

In our study, the most frequent reasons for prescribing CBCT included impacted teeth, implant planning, and cyst or cancer diagnosis followed by endodontic assessment. The reasons given for CBCT requests were similar to the findings of a questionnaire distributed in Sweden and Norway²⁰.

Around 75% of the study population agreed that CBCT imaging has a substantial impact on decision making in endodontics. This finding is in harmony with previous studies, particularly in relation to the diagnosis and treatment planning of difficult cases^{21,22}. Most of the respondents agreed that CBCT imaging had greater ability to detect periapical pathosis than conventional PA. This is in agreement with the results of a recent cadaver study²³.

Additionally, 174 (56.9%) dentists thought that CBCT imaging was more effective in quantifying the extent of cracks in teeth compared with PA. Similarly, earlier studies have found the overall accuracy of CBCT in detecting vertical root fractures in non-root filled teeth and root filled teeth to be higher than that of PA^{24,25}. Most of the dentists (73.5%) in our survey agreed that CBCT scanning is recommended to identify the potential presence of a vertical root fracture.

The respondents were supportive of the higher sensitivity of CBCT

Table 4: Participants' knowledge of cone beam computed tomography applications

Question	Response	Specialty				Total (n = 306)
		GDPs (n = 142)	Overall specialists (n = 164)	Endodontists (n = 46)	Other specialties (n = 118)	
18. CBCT imaging has been found to affect decision making in endodontics significantly	Yes	105 (74%)	124 (75.6%)	42 (91.3%)	82 (69.5%)	229 (74.8%)
	No	11 (7.7%)	12 (7.3%)	1 (2.2%)	11 (9.3%)	23 (7.5%)
	I don't know	26 (18.3%)	28 (17.1%)	3 (6.5%)	25 (21.2%)	54 (17.6%)
19. CBCT imaging has the ability to detect periapical pathosis before it is apparent on 2D radiographs	Yes	94 (66.2%)	106 (64.6%)	35 (76.1%)	71 (60.2%)	200 (65.4%)
	No	8 (5.6%)	5 (3%)	1 (2.2%)	4 (3.4%)	13 (4.2%)
	I don't know	40 (28.2%)	53 (32.3%)	10 (21.7%)	43 (36.4%)	93 (30.4%)
20. CBCT imaging detected 28% more teeth with periapical lesions than conventional periapical radiography	Yes	57 (40.1%)	71 (43.3%)	23 (50%)	48 (40.7%)	128 (41.8%)
	No	5 (3.5%)	6 (3.7%)	2 (4.3%)	4 (3.9%)	11 (3.6%)
	I don't know	80 (56.3%)	87 (53%)	21 (45.7%)	66 (55.9%)	167 (54.6%)
21. CBCT scanning is recommended to identify the potential presence of a vertical root fracture	Yes	103 (72.5%)	122 (74.4%)	37 (80.4%)	85 (72%)	225 (73.5%)
	No	12 (8.5%)	17 (10.4%)	5 (10.9%)	12 (10.2%)	29 (9.5%)
	I don't know	27 (19%)	25 (15.2%)	4 (8.7%)	21 (17.8%)	52 (17%)
22. CBCT imaging as compared with PA is more effective in quantifying the extent of cracks in teeth	Yes	79 (55.6%)	95 (57.9%)	31 (67.4%)	64 (54.2%)	174 (56.9%)
	No	17 (12%)	26 (15.9%)	8 (17.4%)	18 (15.3%)	43 (14.1%)
	I don't know	46 (32.4%)	43 (26.2%)	7 (15.2%)	36 (30.5%)	89 (29.1%)
23. CBCT imaging evaluates periapical lesions and healing after endodontic microsurgery more precisely than PA	Yes	98 (69%)	132 (80.5%)	39 (84.8%)	93 (78.8%)	230 (75.2%)
	No	13 (9.2%)	8 (4.9%)	1 (2.2%)	7 (5.9%)	21 (6.9%)
	I don't know	31 (21.8%)	24 (14.6%)	6 (13%)	18 (15.3%)	55 (18%)
24. CBCT scans can help locate second mesiobuccal canals in maxillary molars	Yes	107 (75.4%)	127 (77.4%)	42 (91.3%)	85 (72%)	234 (76.5%)
	No	9 (6.3%)	5 (3.1%)	1 (2.2%)	4 (3.4%)	14 (4.6%)
	I don't know	26 (18.3%)	32 (19.5%)	3 (6.5%)	29 (24.6%)	58 (19%)
25. CBCT imaging has been recommended to increase accuracy in diagnosing root resorption	Yes	110 (77.5%)	130 (79.3%)	38 (82.6%)	92 (78%)	240 (78.4%)
	No	8 (5.6%)	11 (6.7%)	3 (6.5%)	8 (6.8%)	19 (6.2%)
	I don't know	24 (16.9%)	23 (14%)	5 (10.9%)	18 (15.2%)	47 (15.4%)
26. CBCT is able to detect missed or calcified canals and complex morphology	Yes	112 (78.9%)	131 (79.9%)	44 (95.7%)	87 (73.7%)	243 (79.4%)
	No	7 (4.9%)	6 (3.7%)	0	6 (5.1%)	13 (4.2%)
	I don't know	23 (16.2%)	27 (16.5%)	2 (4.3%)	25 (21.2%)	50 (16.3%)
27. CBCT should not be used routinely for endodontic diagnosis or for screening purposes in the absence of clinical signs and symptoms	Yes	112 (78.8%)	123 (75%)	37 (80.4%)	86 (72.9%)	235 (76.8%)
	No	15 (10.6%)	24 (14.6%)	6 (13%)	18 (15.2%)	39 (12.7%)
	I don't know	15 (10.6%)	17 (10.4%)	3 (6.5%)	14 (11.9%)	32 (10.5%)
	Potential for artifact generation	4 (2.8%)	16 (9.8%)	3 (6.5%)	13 (11%)	20 (6.5%)
	High levels of scatter and noise	18 (12.7%)	20 (12.2%)	6 (13%)	14 (11.9%)	38 (12.4%)
28. For most endodontic applications, limited (small) field of view CBCT is preferred over a medium or large field of view CBCT	All of the above	44 (31%)	44 (26.8%)	17 (37%)	27 (22.9%)	88 (27.8%)
	Yes	78 (55%)	86 (52.4%)	27 (58.7%)	59 (50%)	164 (53.6%)
	No	8 (5.6%)	8 (4.9%)	2 (4.3%)	6 (5.1%)	16 (5.2%)
29. Which of the following are CBCT limitations?	I don't know	56 (39.4%)	70 (42.7%)	17 (37%)	53 (44.9%)	126 (41.2%)
	Possible higher radiation dose to the patient	90 (63.4%)	104 (63.4%)	26 (56.5%)	78 (66.1%)	194 (63.4%)
	Potential for artifact generation	4 (2.8%)	16 (9.8%)	3 (6.5%)	13 (11%)	20 (6.5%)
	High levels of scatter and noise	18 (12.7%)	20 (12.2%)	6 (13%)	14 (11.9%)	38 (12.4%)
	All of the above	44 (31%)	44 (26.8%)	17 (37%)	27 (22.9%)	88 (27.8%)

compared to periapical radiographs in detecting the presence of a 2nd mesio-buccal canal, as shown by Studebaker *et al.* (2018).

The results of the current study also indicated that the participants had good awareness about the diagnostic accuracy of CBCT. Published reports have, moreover, confirmed that CBCT can detect different root conditions which are difficult to identify using PA, including internal 26 and external root resorption^{27,28}, missed or calcified canals²⁹, and complex root morphology³⁰.

According to the European Society of Endodontology (ESE) position statement, CBCT should be used cautiously and considered on a case-by-case basis⁹. Along this line, 235 (76.8%) dentists agreed that CBCT should not be used routinely for endodontic diagnosis or for screening purposes in the absence of clinical signs and symptoms.

Based on the ALARA principle ("as low as reasonably achievable"), small field of view (FOV) CBCT examination should be considered for most endodontic applications⁹. In the existing study, more than half of

the participants (53.6%) were in agreement with that principle.

CBCT has numerous applications in dentistry, but at the same time it has known limitations¹. In this study, high radiation dose to the patient was reported as the most significant limitation for CBCT and the potential for artefact generation as the least.

CONCLUSION

This questionnaire showed that the dentists in Iraq have a very good level of knowledge regarding indications and limitations of CBCT in endodontics, with more significant responses among specialists, including endodontists. Moreover, there is a lack of structured teaching and practical training on the use of CBCT within dental schools. The development of CBCT training programs and increasing the availability of

Table 5: Future attitude of dentists toward CBCT use

Question	Response	Specialty				Total (n = 306)
		GDPs (n = 142)	Overall specialists (n = 164)	Endodontists (n = 46)	Other specialties (n = 118)	
30. To what extent do you feel CBCT will be used in routine dental practice in the future?	In all specialties of dentistry	27 (19%)	43 (26.2%)	10 (21.7%)	33 (28%)	70 (22.9%)
	In selected dental applications	88 (62%)	92 (56.1%)	30 (65.2%)	62 (52.5%)	180 (58.8%)
	It will not be used extensively	7 (4.9%)	9 (5.5%)	3 (6.5%)	6 (5.1%)	16 (5.2%)
	No idea	20 (14.1%)	20 (12.2%)	3 (6.5%)	17 (14.4%)	40 (13.1%)
31. Would you choose to use CBCT in your future professional career?	Yes	73 (51.4%)	105 (64%)	35 (76.1%)	70 (59.3%)	178 (58.2%)
	No	3 (2.1%)	5 (3%)	2 (4.3%)	3 (2.5%)	8 (2.6%)
	Maybe	66 (46.5%)	54 (33%)	9 (25.7%)	45 (38.1%)	120 (39.2%)
31.a. If yes, for which cases would you prefer to use CBCT in your future clinical life?	Evaluation of impacted teeth	8 (11%)	5 (4.8%)	0	5 (7.1%)	13 (7.3%)
	Implant dentistry	29 (39.7%)	38 (36.2%)	6 (17.1%)	32 (45.7%)	67 (37.6%)
	Evaluation of patients with cysts and tumors	8 (11%)	8 (7.6%)	0	8 (11.4%)	16 (9%)
	Endodontics	15 (20.5%)	26 (24.8%)	24 (68.6%)	2 (2.9%)	41 (23%)
	Trauma cases	4 (5.5%)	15 (14.3%)	5 (14.3%)	10 (14.3%)	19 (10.7%)
	Orthodontic assessment	4 (5.5%)	12 (11.4%)	0	12 (17.1%)	16 (9%)
	All of the above	5 (4.8%)	1 (1%)	0	1 (1.4%)	6 (3.4%)

CBCT machines within dental schools are strongly supported by the results of this survey.

DISCLOSURE OF INTEREST

The authors state no conflicts of interest for the presented work.

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