Knowledge, Attitude and Practice of CBCT Among Iraqi Orthodontists

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ABSTRACT

This study aims to assess level of knowledge, attitudes, and practices regarding CBCT among orthodontists and orthodontic practitioners in Iraq. This cross-sectional study was conducted by using electronically constructed questionnaire distributed via email and social media to a total of 150 Iraqi specialists and orthodontic practitioners who were members of Iraqi Orthodontics Society. The questionnaires consisted of 32 multiple choice questions, divided into four segments: demographics (5 variables), knowledge (10 questions), attitude (8 questions) and current practice (9 questions). Demographic questions recorded age, gender, experience years, educational level, and practice sector. Only completed questionnaires were considered for statistical analysis. Mean, percentage, Pearson Chi square and Fisher exact test were performed using SPSS version 22, to compare participants' knowledge, attitude and practice in relation to their educational level and years of experiences, *P-value* ≤ 0.05 was considered to be statistically significant. 126 respondents' questionnaires were returned from a total of 150 Iraqi orthodontic practitioner and specialists. Majority of respondents were females (55.56%), while males were (44.44%), aged 30-39 years (47.62%), followed by 40-49 years (40.48%); most of them work in more than one place (49.21%) and have 1-5 years of experience (44.44%). Masters' degree's holders were the highest percentage (50.79%) among respondents, while the smallest group were having a doctoral degree in orthodontics (7.94%). According to respondents' qualification, no significant differences were found in both knowledge and practice, while significant differences were found only in one question related the attitude. However, there were significant differences among them in attitude and practice according to their years of experience while the knowledge questions showed no significant differences. Results highlight the widespread preference for CBCT among Iraqi orthodontists but reveals gaps in formal training and guideline adherence. Despite variations in attitudes and clinical applications, structured education remains more influential than years of experience in shaping CBCT competency.

Keywords: orthodontist, CBCT, knowledge, attitude, practice

INTRODUCTION

Radiology plays a crucial role in diagnosing dental and maxillofacial conditions. Traditionally, diagnostic imaging in dentistry relied on plain radiographs, such as panoramic radiography. While these conventional methods are sufficient in many cases, advanced imaging techniques, including computed tomography (CT), provide enhanced visualization and improve diagnostic accuracy[1]. CT technology was introduced in the late 20th century, but its widespread use was limited due to factors such as high cost, increased radiation exposure, and limited accessibility. As a result, its application was primarily reserved for complex cases.

The introduction of cone-beam computed tomography (CBCT), also known as cone-beam volumetric imaging (CBVI), has revolutionized three-dimensional (3D) imaging in dentistry, particularly in orthodontics. Over the past two decades, CBCT has gained significant popularity due to its relatively lower cost, reduced radiation dose compared to conventional CT, and rapid scan times. This imaging modality enables high-quality visualization of either the entire maxillofacial skeleton or a localized dento-alveolar region, with minimal distortion[2-5].

The use of CBCT for maxillofacial imaging was first documented by Mozzo et al. in 1988 and later by Arai et al. in 1999. Since then,

CBCT technology has undergone rapid advancements, expanding its applications across various dental specialties[6]. In implant dentistry, CBCT is essential in preoperative planning, allowing precise assessment of the recipient site, bone density, alveolar profile, and the relationship of vital anatomical structures. Additionally, it aids in evaluating the proximity of mandibular third molars to the mandibular canal and assessing pathological conditions or dentoalveolar trauma[7,8]. In orthodontics, CBCT is utilized for analyzing craniofacial structures, assessing skeletal growth patterns, estimating dental age, evaluating impacted teeth, and determining tooth inclination and torque. It also plays a role in measuring alveolar bone width for tooth movement, assessing the temporomandibular joint, analyzing the upper airway, and planning orthognathic surgeries[9].

Despite its numerous applications in orthodontic diagnosis, treatment planning, and research, opinions on its routine use remain divided. There is ongoing debate regarding the appropriate indications for CBCT in orthodontics, and the level of awareness, attitudes, and clinical practices related to CBCT among orthodontists remains unclear. Therefore, this study aims to assess the knowledge, attitudes, and practices regarding CBCT among specialists and practitioners in Iraq.

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The purpose of this study was to investigate the level of knowledge, attitude, and practice of CBCT among specialists and practitioners of orthodontics working in Iraq.

SUBJECTS AND METHODS

In this cross-sectional study, a validated, pretested and self- administered questionnaire was constructed using the Google Forms platform (www. google.com/forms/about/) and electronically distributed via email and social media to a total of 150 Iraqi specialists and practitioners in orthodontics who were members of the Iraqi Orthodontics Society. Each E-mail containing an invitation to enroll in the study voluntarily with clarified aim of study. Over a 2-month period, two e-mail reminders were sent. Based on the number of orthodontists who were members in Iraqi orthodontic society (150), the minimum required sample size to achieve 95 % confidence level and 5 % margin of error was 109. 126 questionnaires were returned. The questionnaires consisted of 32 questions, which were close-ended and previously used in other studies[3,10]. Internal consistency reliability was assessed using Cronbach's alpha. The English language written questionnaire was created and divided into four segments: demographics (5 variables), knowledge (10 questions), attitude (8 questions) and current practice (9 questions). Only completed questionnaires were considered for statistical analysis; and to ensure privacy no personal information was collected.

Demographic questions recorded data concerning age, gender, years of experience, educational level, and practice sector. The research questions include multiple choice questions related to evaluate their knowledge and understanding of CBCT applications and its appropriate clinical indications, and to assess the need for and adequacy of CBCT-related education and training, also to examine awareness of CBCT safety protocols and usage guidelines. While, attitude questions to evaluate participants' perspectives on the utilization, availability, appropriate timing, and ethical considerations of CBCT in orthodontic diagnosis and treatment. As well as questions related to its use.

Statistical Analysis: Data description, analysis and presentation were performed using Statistical Package for social Science (SPSS version -22, Chicago, Illinois, USA), percentage, mean, Pearson Chi square and Fisher exact test were performed to compare participants' knowledge, attitude and practice in relation to their educational level and years of experiences. *P-value* $\leq$ 0.05 was considered to be statistically significant.

RESULTS

In this study the results were divided into two parts, results for the demographic characteristics and the other were for the research questions that included (knowledge, attitude, and practice). The last were divided the respondents according to qualification and years of experiences.

Demographic characteristics

In this study a total of 126 respondents were participated in this questionnaire. It is clear that the majority of respondents were females 55.56% (N. 70), while males were 44.44% (N. 56), and that the majority of respondents were aged 30-39 years (47.62%), followed by 40-49 years (40.48%) as shown in table 1.

Regarding to the place of work, the results showed that most of the respondents work in more than one place (49.21%), followed by their own clinics (34.13%), while the least number of the respondents were

work in governmental specialist health centers and teaching hospitals and recorded (14.29% and 2.38%) respectively. Moreover, the qualification results showed Masters degree's holders were the highest percentage (50.79%, n=64), followed by those with a certification from the Iraqi ministry of health (26.19%, n=33), then participants with a professional diploma from the private centers accounted for 15.08% (n=19), while the smallest group respondents were having a doctoral degree in orthodontics about 7.94% (n=10).

Finally, 44.44% of respondents have 1-5 years of experience and 30.16% have > 10 years, while 25.40% falling within the 5-10 years of experience.

Table 1. Demographic characteristics

Variables		N.	%
Gender	**M**	56	44.44
	F	70	55.56
Age	**30-39**	60	47.62
	40-49	51	40.48
	50-59	15	11.90
Place of work	**Gov.**	18	14.29
	College Hospital	3	2.38
	Private	43	34.13
	>1	62	49.21
Qualification	**Certificate**	33	26.19
	diploma	19	15.08
	M.Sc.	64	50.79
	Ph.D.	10	7.94
Years of experience	**1-5y**	56	44.44
	5-10 y	32	25.40
	>10y	38	30.16

Research questions

The content of this study consists of several questions per KAP domain: Based on qualification that's included 27 questions, 10 questions were belonged to the knowledge of the respondents (table 2), 8 questions according to the attitude of the respondents (table 3), and 9 questions according to the practice of the respondents (table 4).

Regarding the years of experience which included 28 questions, it divided into 11 questions according to the knowledge of the respondents (table 5), 8 questions according to the attitude of the respondents (table 6), and 9 questions according to the practice of the respondents (table 7). The questionnaire was evaluated for both validity and reliability, the results showed good internal consistency for all sections: Knowledge (α=0.851), attitude (α=0.803), and practice (α=0.845).

According to qualification

Based on qualifications, the respondents were divided into academic (Ph.D., M.Sc.,) and Non-academic (Private centers professional diploma, certificate in orthodontics from Iraqi ministry of health). Fisher's exact and Pearson's chi-square tests were used to look for differences between the respondents that were significant at p < 0.05.

As shown in tables (2) and (4), there were no significant differences in the answers of the questions related to both knowledge and practice. However, there were significant differences (p value=**0.005**) in the attitude when asked, "Do you get an informed consent form from the patient before referring them for CBCT?" as shown in Table 3. A total of 66 (52.38%) of the respondents answered with (No) including 46

Table 2. The Knowledge results according to respondents' qualification

Questions	Answers	Qualification				Statistics	Total	
		N. academic		Academic				
		N.	%	N.	%		N.	%T
Which method do you prefer for 3D imaging of the head and neck region? (a)	CT	1	33.33	2	66.67		3	2.38
	CBCT	45	39.13	70	60.87	0.122	115	91.27
	Both	6	75.00	2	25.00		8	6.35
Did you receive any previous advanced CBCT training courses? (b)	Yes	16	41.03	23	58.97	0.970	39	30.95
	No	36	41.38	51	58.62		87	69.05
Do you believe that taking a training course on the use and interpretation of CBCT is necessary? (c)	Yes	37	37.37	62	62.63		99	78.57
	No	9	60.00	6	40.00	0.205	15	11.90
	No idea	6	50.00	6	50.00		12	9.52
In which year of dental education should CBCT lectures be taught? (d)	Under	16	41.03	23	58.97		39	30.95
	Post	16	40.00	24	60.00		40	31.75
	Both	16	38.10	26	61.90	0.391	42	33.33
	Un-necessary	4	80.00	1	20.00		5	3.97
Do you feel that you have received adequate education regarding CBCT? (e)	Yes	11	37.93	18	62.07		29	23.02
	No	33	38.37	53	61.63	0.085	86	68.25
	No idea	8	72.73	3	27.27		11	8.73
When prescribing CBCT, do you take any risk-benefit analysis into account? (e)	Always	15	29.41	36	70.59		51	40.48
	mostly	11	42.31	15	57.69		26	20.63
	Some	17	58.62	12	41.38	0.083	29	23.02
	Unnecessary	9	45.00	11	55.00		20	15.87
Do you believe that a CBCT examination should only be performed when panoramic and cephalometric images cannot sufficiently answer the imaging question? (f)	Yes	40	39.22	62	60.78		102	80.95
	No	10	45.45	12	54.55	0.236	22	17.46
	No idea	2	100.00	0	0.00		2	1.59
Which guidelines you follow for appropriate usage of CBCT? (g)	no G.L	45	43.27	59	56.73		104	82.54
	AAMFR	4	44.44	5	55.56		9	7.14
	AAOMR	2	40.00	3	60.00	0.557	5	3.97
	SADMFR	0	0.00	4	100.00		4	3.17
	SEDETEXCT	1	25.00	3	75.00		4	3.17
Is it possible to get a 2D (lateral cephalogram) image from a CBCT? (h)	Yes	21	32.31	44	67.69		65	51.59
	No	8	50.00	8	50.00	0.108	16	12.70
	No idea	23	51.11	22	48.89		45	35.71
The interpretation of CBCT images is the responsibility of? (i)	Radiologist	11	61.11	7	38.89		18	14.29
	Orthodontist	4	28.57	10	71.43	0.136	14	11.11
	Both	37	39.36	57	60.64		94	74.60

A,d,f,g =Fisher exact, other are Pearson Chi square.

Table 3. The attitude results according to respondents' qualification

Questions	Answers	Qualification				Statistics	Total	
		N. academic		Academic				
		N.	%	N.	%		N.	%
Which type of radiograph that you used mostly for orthodontic diagnosis? (1)	CBCT	3	33.33	6	66.67		9	7.14
	LCP	0	.00	4	100.00		4	3.17
	OPG	42	44.21	53	55.79	0.377	95	75.40
	P.A	2	66.67	1	33.33		3	2.38
	All	5	33.33	10	66.67		15	11.90
At which stage of treatment usually you refer patients for CBCT? (can choose more than one answer) (2)	Beginning	26	35.62	47	64.38		73	57.94
	Middle	23	52.27	21	47.73	0.183	44	34.92
	End	3	33.33	6	66.67		9	7.14
Do you regularly repeat CBCT examination on the same patient during the treatment and at the end of the treatment? (3)	No	24	40.68	35	59.32		59	46.83
	Yes	3	37.50	5	62.50	0.999	8	6.35
	As needed	25	42.37	34	57.63		59	46.83
Do you think that the cost of CBCT radiograph could be a reason for not referring patients regularly? (4)	No	25	37.88	41	62.12		66	52.38
	yes	24	44.44	30	55.56	0.709	54	42.86
	No idea	3	50.00	3	50.00		6	4.76

Do you consider acquiring a CBCT machine in your orthodontic practice place is necessary and imperative in the near future? (5)	No	20	42.55	27	57.45	0.821	47	37.30
	Yes	32	40.51	47	59.49		79	62.70
Do you provide the radiologist with adequate information about the specific interest area of examination and reason for taking CBCT? (6)	No	7	63.64	4	36.36	0.246	11	8.73
	Always	22	36.67	38	63.33		60	47.62
	Some	23	41.82	32	58.18		55	43.65
Do you provide the patient with complete information on CBCT needs and risk including radiation dose? (7)	No	17	47.22	19	52.78	0.390	36	28.57
	Always	9	29.03	22	70.97		31	24.60
	most	9	50.00	9	50.00		18	14.29
	some	17	41.46	24	58.54		41	32.54
Do you obtain an informed consent form from patient before referral for CBCT?(8)	No	20	30.30	46	69.70	0.005	66	52.38
	Always	15	50.00	15	50.00		30	23.81
	Most	8	88.89	1	11.11		9	7.14
	some	9	42.86	12	57.14		21	16.67

A1-A4=Fisher exact, A5-A8=Pearson Chi square.

Table 4. The practice results according to respondents' qualification

Questions	Answers	Qualification				Statistics	Total	
		N. academic		Academic				
		N.	%	N.	%		N.	%
Can CBCT be used for superimposition to assess changes before and after treatment? (1)	Yes	25	41.67	35	58.33	0.846	60	47.62
	No	13	44.83	16	55.17		29	23.02
	No idea	14	37.84	23	62.16		37	29.37
Root resorption is seen better with: (2)	CBCT	25	34.25	48	65.75	0.240	73	57.94
	OPG	4	44.44	5	55.56		9	7.14
	IOPA	10	58.82	7	41.18		17	13.49
	All	13	48.15	14	51.85		27	21.43
Cleft palate is seen better with: (3)	CBCT	45	41.67	63	58.33	0.684	108	85.71
	OPG	3	50.00	3	50.00		6	4.76
	IOPA	0	0.00	2	100.00		2	1.59
	All	2	28.57	5	71.43		7	5.56
	None	2	66.67	1	33.33		3	2.38
Determination of the exact location of impacted teeth is better evaluated with:(4)	CBCT	47	40.17	70	59.83	0.063	117	92.86
	OPG	1	25.00	3	75.00		4	3.17
	IOPA	0	0.00	1	100.00		1	0.79
	All	4	100.00	0	0.00		4	3.17
Periodontal status can be best viewed by?(5)	CBCT	8	32.00	17	68.00	0.287	25	19.84
	OPG	8	53.33	7	46.67		15	11.90
	IOPA	6	28.57	15	71.43		21	16.67
	Clinically	21	51.22	20	48.78		41	32.54
	All	9	37.50	15	62.50		24	19.05
Bone height, width is better evaluated with:(6)	CBCT	41	39.05	64	60.95	0.510	105	83.33
	OPG	4	66.67	2	33.33		6	4.76
	IOPA	2	40.00	3	60.00		5	3.97
	All	4	44.44	5	55.56		9	7.14
	None of them	1	100.00	0	0.00		1	0.79
Can CBCT be used for determination of the ideal location for mini-implant placement? (7)	Yes	22	46.81	25	53.19	0.650	47	37.30
	No	3	37.50	5	62.50		8	6.35
	radiation problem	22	36.07	39	63.93		61	48.41
	I don't know	5	50.00	5	50.00		10	7.94
Can orthognathic surgery outcome be visualized with CBCT? (8)	few	5	27.78	13	72.22	0.365	18	14.29
	Yes	41	45.05	50	54.95		91	72.22
	No	6	35.29	11	64.71		17	13.49
Airway space is better analyzed with: (9)	CBCT	13	28.26	33	71.74	0.190	46	36.51
	OPG	2	66.67	1	33.33		3	2.38
	LCP	20	52.63	18	47.37		38	30.16
	All	8	44.44	10	55.56		18	14.29
	None	9	42.86	12	57.14		21	16.67

P1-P2,p5,p7=Pearson chi square, others are Fisher exact

Table 5. The knowledge results of respondents according to years of experience

| Questions | Answers | Years of experience | | | | | | FEPT |
| | | 1-5y | | 5-10 y | | >10y | | |
		N.	%	N.	%	N.	%	
Which method do you prefer for 3D imaging of the head and neck region?	CT	2	66.67	1	33.33	0	0.00	0.564
	CBCT	50	43.48	28	24.35	37	32.17	
	Both	4	50.00	3	37.50	1	12.50	
Did you receive any previous advanced CBCT training courses?	Yes	15	38.46	8	20.51	16	41.03	0.234
	No	41	47.13	24	27.59	22	25.29	
Do you believe that taking a training course on the use and interpretation of CBCT is necessary?	Yes	43	43.43	23	23.23	33	33.33	0.489
	No	7	46.67	6	40.00	2	13.33	
	No idea	6	50.00	3	25.00	3	25.00	
In which year of dental education should CBCT lectures be taught?	Under	16	41.03	12	30.77	11	28.21	0.724
	Post	21	52.50	8	20.00	11	27.50	
	Both	18	42.86	11	26.19	13	30.95	
	Un-necessary	1	20.00	1	20.00	3	60.00	
Do you feel that you have received adequate education regarding CBCT?	Yes	12	41.38	9	31.03	8	27.59	0.284
	No	37	43.02	23	26.74	26	30.23	
	No idea	7	63.64	0	.00	4	36.36	
When prescribing CBCT, do you take any risk-benefit analysis into account?	Always	17	33.33	14	27.45	20	39.22	0.096
	mostly	9	34.62	10	38.46	7	26.92	
	Some	18	62.07	4	13.79	7	24.14	
	Unnecessary	12	60.00	4	20.00	4	20.00	
Do you think that CBCT can be used as an alternative for panoramic and cephalometric image?	Yes	27	45.00	16	26.67	17	28.33	0.420
	No	24	48.98	9	18.37	16	32.65	
	No idea	5	29.41	7	41.18	5	29.41	
Do you believe that a CBCT examination should only be performed when a panoramic and cephalometric image cannot sufficiently answer the imaging question?	Yes	45	44.12	29	28.43	28	27.45	0.430
	No	10	45.45	3	13.64	9	40.91	
	No idea	1	50.00	0	.00	1	50.00	
Which guidelines you follow for appropriate usage of CBCT?	no G.L	50	48.08	24	23.08	30	28.85	0.081
	AAMFR	3	33.33	4	44.44	2	22.22	
	AAOMR	1	20.00	0	.00	4	80.00	
	SADMFR	1	25.00	3	75.00	0	.00	
	SEDETEXCT	1	25.00	1	25.00	2	50.00	
Is it possible to get a 2D (lateral cephalogram) image from a CBCT?	Yes	30	46.15	14	21.54	21	32.31	0.632
	No	5	31.25	5	31.25	6	37.50	
	No idea	21	46.67	13	28.89	11	24.44	
The interpretation of CBCT images is the responsibility of?	Radiologist	10	55.56	4	22.22	4	22.22	0.205
	Orthodontist	3	21.43	3	21.43	8	57.14	
	Both	43	45.74	25	26.60	26	27.66	

(69.70%) participants with academic qualification and 20 (30.30%) participants with non-academic qualification. Moreover, the other attitude questions did not record any significant differences at p < 0.05.

According to years of experiences

In this study, the knowledge, attitude, and practice results were represented according to the years of experience of the participants which included (1-5 years, 5-10 years, and >10 years). For the knowledge, regardless of the number and nature of the questions that were asked, the total results of 126 respondents that shown in table (5) did not record any significant differences at p < 0.05 among the respondents with the different years of experiences that mentioned above. Additionally, the attitude results revealed statistically significant differences (p value =**0.013**) in the answers for the question, "Do you think that the cost of a CBCT radiograph could be a reason for not referring patients regularly?" as 59.26% (n=32) of answers were (yes) for respondents with 1-5 years of experience compared to **>10 years (16.67%)**, while for (No) answer the highest percentage of the respondents were in >10 years (40.91%, n=27). Also, the results reported a significant (p value = **0.040**) for the question, "Do you consider acquiring a CBCT machine in your orthodontic practice place

is necessary and imperative in the near future?" with a percentage 53.19% of respondents with (1-5 years) answered (No) and for the same answer represented 34.04%, 12.77% for >10 years and 5-10 years respectively. However, the other questions did not record any significant difference between respondents, as in table (6).

Regarding the practice results, all the questions showed no significant differences among the respondents except in the question 'the airway space is better analyzed with' there were statistically significant differences (p value =**0.012**) as highest percentage (63.16%), selected the lateral cephalometric radiograph and fall in 1-5 years of experience, In contrast, this method was far less preferred by clinicians with **5-10 years** (26.32%) and **>10 years** (10.53%) of experience , while (47.83%) of the respondents with >10 years preferred CBCT compared to those with **1-5 years** (32.61%) as shown in table (7).

DISCUSSION

Dental imaging has advanced from traditional 2D methods to 3D techniques, significantly enhancing diagnostic accuracy and treatment planning. Cone-beam computed tomography (CBCT) has revolutionized orthodontics by providing detailed 3D visualization of

Table 6. The Attitude results of respondents according to years of experience

| Questions | Answers | Years of experience | | | | | | FEPT |
| | | 1-5y | | 5-10 y | | >10 | | |
		N.	%	N.	%	N.	%	
Which type of radiograph that you used mostly for orthodontic diagnosis?	CBCT	3	33.33	2	22.22	4	44.44	0.627
	LCP	2	50.00	2	50.00	0	.00	
	OPG	44	46.32	25	26.32	26	27.37	
	P.A	1	33.33	1	33.33	1	33.33	
	All	6	40.00	2	13.33	7	46.67	
At which stage of treatment usually you refer patients for CBCT? (can choose more than one answer)	Beginning	37	50.68	16	21.92	20	27.40	0.542
	Middle	16	36.36	13	29.55	15	34.09	
	End	3	33.33	3	33.33	3	33.33	
Do you regularly repeat CBCT examination on the same patient during the treatment and at the end of the treatment?	No	27	45.76	13	22.03	19	32.20	0.891
	Yes	3	37.50	2	25.00	3	37.50	
	As needed	26	44.07	17	28.81	16	27.12	
Do you think that the cost of CBCT radiograph could be a reason for not referring patients regularly?	No	21	31.82	18	27.27	27	40.91	0.013
	yes	32	59.26	13	24.07	9	16.67	
	No idea	3	50.00	1	16.67	2	33.33	
Do you consider acquiring a CBCT machine in your orthodontic practice place is necessary and imperative in the near future?	No	25	53.19	6	12.77	16	34.04	0.040
	Yes	31	39.24	26	32.91	22	27.85	
Do you provide the radiologist with adequate information about the specific interest area of examination and reason for taking CBCT?	No	6	54.55	1	9.09	4	36.36	0.748
	Always	26	43.33	15	25.00	19	31.67	
	Some	24	43.64	16	29.09	15	27.27	
Do you provide the patient with complete information on CBCT needs and risk including radiation dose?	No	18	50.00	9	25.00	9	25.00	0.554
	Always	11	35.48	8	25.81	12	38.71	
	most	6	33.33	4	22.22	8	44.44	
	some	21	51.22	11	26.83	9	21.95	
Do you obtain an informed consent form from patient before referral for CBCT?	No	32	48.48	17	25.76	17	25.76	0.482
	Always	15	50.00	7	23.33	8	26.67	
	Most	4	44.44	2	22.22	3	33.33	
	some	5	23.81	6	28.57	10	47.62	

Table 7. The practice results of respondents according to years of experience

Questions	Answers	Years of experience						FEPT
		1-5y		5-10 y		>10		
		N.	%	N.	%	N.	%	
Can CBCT be used for superimposition to assess changes before and after treatment?	Yes	28	46.67	17	28.33	15	25.00	
	No	13	44.83	6	20.69	10	34.48	0.798
	No idea	15	40.54	9	24.32	13	35.14	
Root resorption is seen better with:	CBCT	33	45.21	16	21.92	24	32.88	
	OPG	5	55.56	3	33.33	1	11.11	
	IOPA	11	64.71	2	11.76	4	23.53	0.132
	All	7	25.93	11	40.74	9	33.33	
Cleft palate is seen better with:	CBCT	49	45.37	28	25.93	31	28.70	
	OPG	2	33.33	3	50.00	1	16.67	
	IOPA	2	100.00	0	0.00	0	0.00	0.446
	All	2	28.57	1	14.29	4	57.14	
	None	1	33.33	0	0.00	2	66.67	
Determination of the exact location of impacted teeth is better evaluated with:	CBCT	54	46.15	29	24.79	34	29.06	
	OPG	1	25.00	1	25.00	2	50.00	0.309
	IOPA	1	100.00	0	.00	0	0.00	
	All	0	.00	2	50.00	2	50.00	
Periodontal status can be best viewed by?	CBCT	12	48.00	5	20.00	8	32.00	
	OPG	7	46.67	4	26.67	4	26.67	
	IOPA	8	38.10	6	28.57	7	33.33	0.933
	Clinically	21	51.22	10	24.39	10	24.39	
	All	8	33.33	7	29.17	9	37.50	
Bone height, width is better evaluated with:	CBCT	48	45.71	29	27.62	28	26.67	
	OPG	2	33.33	1	16.67	3	50.00	
	IOPA	1	20.00	0	.00	4	80.00	0.421
	All	4	44.44	2	22.22	3	33.33	
	None of them	1	100.00	0	.00	0	.00	
Can CBCT be used for determination of the ideal location for mini-implant placement?	Yes	22	46.81	14	29.79	11	23.40	
	No	3	37.50	3	37.50	2	25.00	
	radiation problem	29	47.54	13	21.31	19	31.15	0.374
	I dont know	2	20.00	2	20.00	6	60.00	
Can orthognathic surgery outcome be visualized with CBCT?	few	7	38.89	4	22.22	7	38.89	
	Yes	42	46.15	22	24.18	27	29.67	0.790
	No	7	41.18	6	35.29	4	23.53	
Airway space is better analyzed with:	CBCT	15	32.61	9	19.57	22	47.83	
	OPG	1	33.33	1	33.33	1	33.33	
	LCP	24	63.16	10	26.32	4	10.53	0.012
	All	6	33.33	5	27.78	7	38.89	
	None	10	47.62	7	33.33	4	19.05	

skeletal structures, improved airway assessment, and greater precision in treatment. However, its effective use depends on orthodontists' knowledge, attitudes, and practical application.

This study aimed to assess the current level of knowledge, perceptions, and utilization patterns of CBCT among Iraqi orthodontists either specialists with academic qualification or practitioners with non – academic degree, offering valuable insights into their readiness to adopt this technology. The following discussion will analyze the key findings, compare them with previous studies, and explore the implications for orthodontic education and practice in Iraq.

Knowledge of CBCT

Our survey found no significant differences in CBCT knowledge based on either qualification or years of experience. Overall, a significant majority of respondents (91.27%) preferred CBCT to conventional CT when 3D imaging of the head and neck region was required,

acknowledging its superior diagnostic capabilities, reduced radiation dose, and accuracy in all three planes. As CBCT provides a 1:1 geometry, with no magnification errors, making it an ideal imaging modality for orthodontic assessment[11]. Previous studies have similarly found that most practitioners favored CBCT over CT for head and neck imaging[3, 12].

Regarding training, according to the European Academy of Dento-maxillofacial radiology states that there are two levels of CBCT training[13]: First, the basic level, which allows prescription and patient referral, and the advanced level, which enables dentists to interpret CBCT readings. More than half of respondents (69.05%) had only basic training, and only 30.95% received advanced courses, with academic orthodontists showing slightly higher participation (58.97%). This gap in training likely contributed to 68.25% of participants feeling inadequately educated on CBCT, even with increased years of

experience. Studies have shown that clinical experience alone does not compensate for formal training in CBCT interpretation, as structured education plays a crucial role in developing diagnostic proficiency and ensuring proper CBCT utilization[13, 14]. Also the majority of our participants (78.57%, n=99), including both academic (62.63%, n=62) and non-academic practitioners (37.37%, n=37), agreed on the importance of CBCT training courses, particularly among non-academic practitioners.

Regarding when CBCT should be introduced in dental education, responses were nearly evenly split: 33.33% preferred both undergraduate and postgraduate levels, 31.75% favored postgraduate training, and 30.95% recommended undergraduate instruction. Studies have highlighted that early exposure to CBCT in undergraduate programs, combined with advanced training at the postgraduate level, enhances competency[15]. A systematic review also emphasized the need to incorporate CBCT into the Bachelor of Dental Surgery (BDS) curriculum and recommended conducting more workshops on CBCT usage[16-18].

Decision-making varied, with 40.48% of respondents consistently performing a risk-benefit analysis before prescribing CBCT, particularly academic specialists (70.59%), whereas a notable portion of non-academic practitioners (58.62%) were less consistent. This outlines the need for standardized guidelines to reinforce the importance of appropriate CBCT utilization in clinical practice. Additionally, 80.95% agreed CBCT should only be used when 2D imaging is insufficient, aligning with international guidelines. However, 17.46% believed CBCT could be used more routinely, suggesting a tendency for overuse due to a lack of standardized guidelines Research suggests that a lack of proper education and standardized guidelines often leads to unnecessary CBCT prescriptions, reinforcing the need for awareness campaigns and guideline implementation[19].

Alarmingly, 82.54% of respondents did not follow any specific CBCT guidelines, with only a small percentage adhering to internationally recognized protocols such as AAOMR (3.97%), AAMFR (7.14%), SADMFR (3.17%), or SEDENTEXCT (3.17%). These findings contrasting with an Indian study[3], where 50% followed the SEDENTEXCT protocol. The low adherence to standardized guidelines is concerning, as it may lead to inconsistent and potentially unnecessary CBCT prescriptions.

Regarding interpretation, 74.60% supported shared responsibility between orthodontists and radiologists, underscoring the need for interdisciplinary collaboration, as well as the need for orthodontists to receive adequate radiological training to enhance diagnostic accuracy. In terms of years of experience, orthodontists with over 10 years of practice demonstrated better CBCT knowledge in several aspects, particularly regarding CBCT training and risk-benefit analysis. However, even among experienced practitioners, gaps in guideline adherence and formal education were evident, suggesting that knowledge acquisition is more dependent on structured training rather than clinical experience alone.

Attitudes toward CBCT

The attitude results showed a significant variation in responses based on qualification and years of experience. One of the key findings was that 52.38% of respondents did not obtain informed consent before referring patients for CBCT, with academically qualified orthodontists (69.70%, n= 46) being more likely to neglect consent compared to non-academic practitioners (30.30%, n=20). This raises ethical concerns, as informed consent is a fundamental principle in patient care and

aligns with international radiographic guidelines[20, 21]. Regarding financial considerations, a significant difference was observed among orthodontists based on experience levels ($p < 0.05$).

The majority of early-career practitioners (1-5 years) believed the **cost of CBCT was a limiting factor** (59.26%), while most senior orthodontists (>10 years) did not consider cost as a major concern (40.91%). This finding suggests that younger orthodontists, possibly working in associate roles or in poor popular areas where patient cannot afford the cost of CBCT or facing financial constraints, are more sensitive to CBCT affordability. Previous studies have identified cost as a key barrier to CBCT adoption, especially in developing regions[22]. Additionally, the necessity of acquiring a CBCT machine was perceived differently across experience groups ($p < 0.05$). The highest proportion of respondents considering CBCT acquisition un- necessary were in the 1-5 year experience group (53.19% %), followed by those with >10 years (34.04% %) and 5-10 years (12.77% %). This suggests that **less experienced orthodontists are significantly more hesitant** about acquiring a CBCT machine compared to more experienced specialists or practitioners who recognize the clinical advantages of CBCT, such as its ability to provide high-resolution 3D images that can improve outcomes in complex cases[23].

CBCT Practice Patterns

When responses were analyzed based on qualification, no statistically significant differences were observed across most CBCT applications. Both academic and non-academic orthodontists demonstrated similar clinical decision-making patterns, with widespread agreement on CBCT's role in impacted tooth localization (92.86%), cleft palate diagnosis (85.71%), and bone assessments (83.33%). These findings are consistent with literature supporting CBCT's superior spatial resolution for **impacted tooth localization**[24], its **preference** in cleft palate diagnosis when **radiation dose is a concern**[25], and its ability to provide **detailed three-dimensional images of bone structures, enabling precise evaluation of bone quality and quantity**[9]. Additionally, while 47.62% of respondents recognized CBCT's role in treatment progress superimposition, a notable proportion **(29.37%)** were uncertain about this application, reflecting variability in practical training. Similar uncertainty was observed in mini-implant placement, where only 37.30% correctly identified CBCT as the ideal modality, while 48.41% expressed concerns regarding radiation exposure. Interestingly, the **hesitation was slightly higher among academic specialists (63.93%) compared to non-academic practitioners (36.07%).**

This could be attributed to **their stronger theoretical background**, which places greater emphasis on **risk assessment, radiation safety, and justification for CBCT use.** In contrast, **non-academic practitioners, such as those with professional diplomas or certificates, may have more hands-on clinical experience** and therefore be **more inclined to use CBCT in daily practice when available.** This highlights the need for further education on balancing CBCT's benefits and risks in practice. Regarding periodontal assessment, **only 19.84% of respondents considered CBCT the best modality**, while **32.54% relied solely on clinical examination**. This raises concerns about underutilization, as CBCT has been shown to provide **detailed visualization of bone loss and periodontal defects**[26]**.** The lack of standardized CBCT protocols for periodontal evaluation may contribute to this gap, reinforcing the need for greater awareness of its benefits in **periodontal diagnosis and** treatment **planning.**

A significant difference was noted in the **use of CBCT for airway space analysis ($p < 0.05$) according to the years of experiences**. Most participants with 1-5 years of practice predominantly selected

lateral cephalometric radiographs (63.16%), while those with >10 years preferred CBCT (47.83%). This finding suggests that **experienced orthodontists, having managed more complex cases, recognize the advantages of CBCT in airway assessment,** whereas **younger practitioners adhere to conventional 2D imaging, possibly due to concerns about radiation exposure.** Studies have highlighted that CBCT measurements for airway assessment are dependable and consistent[27-29], aiding in the diagnosis and treatment of conditions such as **obstructive sleep apnea.** However, the potential bias of the current study due to self-reporting

CONCLUSION

The study results highlight the widespread preference for CBCT among Iraqi orthodontists but reveals gaps in formal training and guideline adherence. Despite variations in attitudes and clinical applications, structured education remains more influential than years of experience in shaping CBCT competency. Addressing these gaps through standardized training, improved guideline awareness, and interdisciplinary collaboration is crucial to ensure optimal CBCT utilization across all levels of orthodontic practice.

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