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A Comparison between Saudi Dental Students' Knowledge of CBCT and Intraoral Radiographs: A Cross-Sectional Study

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ABSTRACT

Intraoral radiography is integral to dental diagnosis while cone beam computed tomography (CBCT) provides enhanced 3D visualization. We aimed to assess and compare knowledge regarding CBCT and intraoral radiography among 386 Saudi dental undergraduates via a cross-sectional questionnaire. Nearly all participants successfully identified bitewing (99%), periapical (97%) and CBCT (98%) images, indicating strong familiarity. However, only 6% had clinically utilized CBCT versus 80% using intraoral radiography. Just 14% received CBCT training compared to 65% trained in intraoral radiography. Most appropriately recognized children as the most radiation-sensitive group (47%) and recommended limited CBCT (62%) and intraoral (37%) radiographs monthly per ALARA principles. Root canal treatment (44%) and implant planning (29%) were the most common CBCT referral indications. Key barriers to routine CBCT implementation included high costs (67%), difficulty (16%), and insufficient training (14%). Advantages perceived were reduced radiation (17%), rapid imaging (38%), and lack of film processing (24%). Results highlight excellent conceptual understanding but limited practical experience and training in CBCT compared to intraoral radiography among Saudi dental students. Targeted education programs integrating hands-on CBCT exposure with training in radiation safety and appropriate use are warranted to support optimal future clinical adoption.

Key words: Dental Trauma, Knowledge, Dental Student, Saudi Arabia.

1. INTRODUCTION

Intraoral radiography comprising bitewing, periapical and occlusal projections plays an indispensable role in routine dental diagnosis, treatment planning and monitoring [1]. It provides 2D visualization of dental anatomy and pathology to assess caries, periodontal status, pulp pathology, trauma, and pre-surgical status [1-3]. While intraoral techniques continue to be widely utilized, cone beam computed tomography (CBCT) has emerged as an advanced 3D imaging modality with growing applications across dentistry over the past two decades [4,5]. CBCT overcomes limitations of conventional 2D radiography including magnification, distortion, overlapping structures and inability to visualize buccolingual dimensions [4,6]. It produces sub-millimeter isotropic voxel resolution images enabling detailed evaluation of bone and dental anatomy [4,7].

Unlike conventional fan-beam CT, CBCT captures the entire head with one rotational scan using a cone-shaped x-ray beam and flat-panel detector [7,8]. This reduces radiation exposure compared to conventional CT while providing accurate 3D renderings of maxillofacial anatomy [7,9,10]. CBCT has proven utility across all dental specialties including diagnosis and treatment planning for implants [5,11,12], endodontics [4,13,14], orthodontics [5,15,16], surgery [17,18] and temporomandibular joints [7,19,20]. It also benefits assessment of pathology, trauma, temporomandibular disorders, cleft palate, and pre-surgical planning [5,7,21]. Despite advantages, CBCT has limitations including higher radiation dose than intraoral radiography, poorer soft tissue contrast, and artifacts [10,22]. It must be judiciously applied based on expected diagnostic yield and radiation safety considerations per published selection criteria [23-25].

While CBCT usage is rising in dentistry, conventional 2D radiography still predominates daily practice [26,27]. Intraoral techniques like bitewing and periapical X-rays provide sufficient information for most routine diagnostic tasks and monitoring [26]. Studies show limited integration of CBCT by dental practitioners due to financial constraints, inadequate training, and lack of guidelines [10,28]. New dental graduates will determine future CBCT adoption patterns, hence assessing their knowledge and early clinical experience with this advanced imaging is pertinent [29,30]. However, there is insufficient research evaluating Saudi dental students' perspectives and skills in CBCT compared to widely taught intraoral radiography [31]. One study on a Saudi general dentist sample found limited CBCT knowledge and training, identifying needs [28].

Dental curricula must evolve to provide both strong theoretical knowledge regarding CBCT technology along with sufficient practical learning to support appropriate, safe utilization [29,30]. Hence, this study aimed to assess and compare foundational knowledge pertaining to CBCT and conventional intraoral radiography among a cohort of dental undergraduates across five Saudi universities. It evaluated their awareness, early clinical experiences, referral practices, perspectives on advantages and limitations, and training received in both imaging modalities. Identifying knowledge gaps regarding CBCT can highlight areas for enhanced curricular emphasis and training to facilitate optimal future clinical adoption of this 3D technology.

2. MATERIALS AND METHODS

2.1 Study Design and Administration

This cross-sectional questionnaire-based study was conducted among dental undergraduates from five universities in Riyadh, Saudi Arabia during the 2022-2023 academic year. Ethical approval was obtained from the Institutional Review Board at Riyadh Elm University. The English language questionnaire adapted from previous studies [10,12-14] was pretested on 10 dental faculty for validation and clarity. Hard copies were distributed to Yemeni students while the online version created via Google Forms was emailed to remaining participants for voluntary completion. Responses were anonymous with no identifiers recorded.

2.2 Study Sample and Inclusion Criteria

The study sample comprised 386 dental undergraduates including pre-clinical students from levels 5-7 and clinical students from levels 8-12 along with dental interns. Undergraduates were targeted to assess early CBCT knowledge and experience as they determine future adoption patterns. Students who repeated academic years were excluded to avoid duplication. Participation was elective with informed consent. The questionnaire required 10-15 minutes for completion.

2.3 Questionnaire Contents

The final questionnaire consisted of two sections:

1. Demographics: Age, gender, university, and education level
2. CBCT and Intraoral Radiography Knowledge:
- Identification of radiographic images: Bitewing, periapical and CBCT
- Age group considered most radiosensitive
- Recommended CBCT and intraoral radiographs per month
- Appropriate CBCT referral indications
- Barriers to routine CBCT implementation
- Perceived CBCT advantages
- Clinical usage of CBCT and intraoral radiography
- Receipt of CBCT and intraoral radiography training

Most questions were close-ended multiple choice format with single best response. Options for questions on appropriate use, advantages and barriers were compiled based on published evidence and guidelines.

2.4 Data Analysis

Data were analyzed using IBM SPSS Version 28.0. Descriptive statistics determined frequency distributions. Bivariate comparisons were performed using chi-square tests to identify variations in knowledge by university, gender and education level. Statistical significance was set at $p<0.05$.

3. RESULTS

3.1 Participant Demographics and Radiography Training

Table 1 summarizes respondent demographics. Among the 386 participants, most were males (78%) versus females (22%). The predominant age group was 21-25 years (94%). The majority were students in clinical years 8-12 (61%) while the rest were in preclinical years 5-7 (39%). Most respondents were from Riyadh Elm University (64%) followed by other private and public institutions.

Regarding radiography training, only 14% had received CBCT education compared to 65% trained in intraoral techniques (Table 1). Correspondingly, just 6% reported clinical use of CBCT versus 80% utilizing intraoral radiography (Table 1).

Table 1: Participant demographics and radiography training (n=386)

Variable	n (%)
Gender	
Male	300 (78%)
Female	86 (22%)
Age (years)	
<20	23 (6%)
21-25	362 (94%)
>26	1 (0.3%)
Education Level	
Preclinical (Levels 5-7)	150 (39%)
Clinical (Levels 8-12)	236 (61%)
University	
Riyadh Elm University	247 (64%)
Dar Al Uloom University	44 (11%)
King Saud University	28 (7%)
Princess Nourah University	21 (5%)
King Saud bin Abdulaziz University	21 (5%)
Vision Colleges	25 (6%)
Used CBCT clinically	23 (6%)
Received CBCT training	54 (14%)
Used intraoral radiography clinically	309 (80%)
Received intraoral radiography training	249 5%)

3.2 CBCT and Intraoral Radiography Knowledge

Most respondents successfully identified the images for bitewing (99%), periapical (97%) and CBCT (98%) radiography, reflecting strong familiarity (Figure 1). In terms of radiosensitivity, 47% correctly recognized children as the age group most vulnerable to radiation (Table 2). Regarding recommended images per month, 62% appropriately chose 1-5 CBCT scans, while 37% selected 1-5 intraoral radiographs, indicating understanding of limiting radiation exposure (Table 2).

For CBCT referral, root canal treatment (44%) and dental implant planning (29%) were the most frequently chosen by respondents (Table 2). These align with established CBCT indications for endodontic diagnosis and implant site assessment [4,5,11-14].

The leading barriers cited for limited CBCT adoption were high costs (67%), difficulty (16%), and inadequate education/training (14%) (Table 2). Key advantages perceived were reduced radiation versus conventional CT (17%), rapid scan time (38%), and lack of film processing (24%) (Table 2).

Table 2: CBCT and intraoral radiography knowledge

Knowledge Question	Response	n (%)
Most radiosensitive age group	Children	180 (47%)
	Teens	27 (7%)
	Adults	118 (31%)
	Elderly	61 (16%)
Recommended CBCT scans per month	1-5	239 (62%)
	6-10	106 (27%)
	>10	41 (11%)
Recommended intraoral radiographs per month	1-5	142 (37%)
	6-10	121 (31%)
	>10	123 (32%)
CBCT referral indications	Root canal treatment	170 (44%)
	Implant planning	113 (29%)
	Cysts/tumors	48 (12%)
	Trauma	55 (14%)
Main barriers to CBCT adoption	High costs	260 (67%)
	Difficulty	63 (16%)
	Lack of training	54 (14%)
	Lack of access	40 (10%)
Perceived CBCT advantages	Reduced radiation	66 (17%)
	Rapid imaging	147 (38%)
	Digital format	93 (24%)
	Multiplanar views	82 (21%)

4. DISCUSSION

This study provides valuable insights into CBCT and intraoral radiography knowledge among Saudi dental undergraduates. Participants demonstrated excellent understanding of intraoral and CBCT images, reflecting strong conceptual familiarity developed through teaching of basic imaging principles and techniques. Nearly all respondents successfully identified bitewing, periapical and CBCT images, comparable to previous dental student studies showing high awareness [10,12]. However, there appear to be gaps in experiential learning as only 6% had used CBCT clinically versus 80% employing intraoral radiography. This low CBCT utilization aligns with prior research quoting rates under 10% among students internationally [10,13,32].

The lack of practical CBCT exposure is further evidenced by minimal formal training, with only 14% of participants having received CBCT education versus 65% trained in intraoral radiography. This resonates with findings showing limited integration of dedicated CBCT teaching within dental curricula globally [29,30]. While students gain excellent conceptual grasp of CBCT fundamentals through lectures, deficient hands-on training poses barriers to clinical implementation [28-30]. The significant gap between theoretical knowledge and practical skills highlights the need for expanded CBCT training initiatives enabling supervised utilization and interpretation.

However, students demonstrated sound conceptual knowledge on key aspects like radiation safety and appropriate CBCT usage. Nearly half correctly identified children as the most radiosensitive group, and most recommended limited CBCT and intraoral radiographs monthly per ALARA principles of minimizing radiation exposure. This aligns with previous research showing retention of core concepts taught regarding radiosensitivity and radiation protection [10,33]. Though one study found students lacked thorough understanding of CBCT exposure parameters and doses [14], Saudi undergraduates surveyed exhibited appropriate attitudes favoring conservative imaging.

Students also appeared cognizant of established CBCT applications like endodontic diagnosis and implant site assessment based on their referral preferences [4,5,11-14]. But theoretical knowledge on guidelines for judicious use must be supplemented with clinical experience to impart nuanced discernment for CBCT justification according to individual patient needs [23-25,34]. Ongoing training is essential to ensure referring practitioners have the expertise to appropriately acquire, interpret and integrate CBCT findings for enhanced diagnosis and treatment planning [23].

Financial constraints were considered the main impediment to routine CBCT implementation, consistent with previous research [10,28,35]. However, reducing CBCT costs through availability of institutional machines mitigates this barrier, as evidenced by more frequent student usage internationally at facilities with in-house units [10,13,36]. Difficulties in technique performance and interpretation also deterred adoption, affirming the need for expanded hands-on training

within dental curricula to improve competence and confidence [29,30].

Students recognized key CBCT advantages like low radiation versus CT, rapid scans, and digital format which bodes well for future acceptance. However, education must emphasize that radiation dose remains higher than conventional dental radiography, precluding universal implementation. While undergraduates exhibited good conceptual knowledge overall, substantive training integrating theoretical learning with practical experience is essential to support appropriate CBCT utilization in future practice.

5. CONCLUSION

This questionnaire-based study assessed and compared foundational knowledge regarding CBCT and intraoral radiography among Saudi dental undergraduates. Students demonstrated strong conceptual familiarity but limited practical experience with the advanced CBCT modality compared to widely taught conventional intraoral techniques. Targeted education programs providing supervised CBCT exposure integrated with training in radiation safety, optimized scan parameters, and purpose-driven referral practices can help address knowledge gaps. Expanding curricular emphasis on appropriate CBCT utilization will enable graduates to apply this 3D technology to enhance diagnosis and treatment planning when justified to benefit patient care.

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The authors have no conflicts of interest to declare regarding this research. This study was ethically conducted in compliance with regulations.

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