Awareness and Utilization of Dental Imaging among General Dentists: The Role of Radiologists in Continuing Education

Faisal M. Al Sonbul[1], Noura I. Alrediny[2], Shahla S. Aldegheishem[3], Hanan S. Alanazi[4], Wafa I. Alotaibi[5], Faisal E. Aljwuaied[6]

Health Affairs at the Ministry of National Guard

Abstract

Background: Cone-beam computed tomography (CBCT) is a transformative tool in dental diagnostics, offering enhanced precision in treatment planning. However, its utilization among general dentists remains limited due to barriers such as cost, access, and insufficient training.

Objective: This study aimed to assess the awareness, utilization, and educational needs of general dentists regarding CBCT in a tertiary hospital setting.

Methods: A cross-sectional survey of 120 general dentists was conducted using a structured questionnaire. Data on demographics, CBCT awareness, utilization practices, barriers, and continuing education needs were analyzed using descriptive and inferential statistics.

Results: While 85% of participants were aware of CBCT, only 40% reported regular use. Barriers included high costs (70%), limited access to machines (55%), and lack of confidence in interpreting scans (48%). A significant association was found between clinical experience and CBCT utilization ($p<0.05$). Additionally, 78% of dentists expressed a strong need for training, with hands-on workshops being the most preferred format.

Conclusion: Although awareness of CBCT is high, practical barriers and training gaps limit its use. Addressing these issues through targeted education and infrastructure investment can enhance the adoption of CBCT and improve patient care.

Keywords: Cone-Beam Computed Tomography, Dental Imaging, Continuing Education, CBCT Utilization, Dental Radiology, Training Needs.

Introduction

The adoption of advanced imaging technologies has revolutionized the field of dentistry, enhancing diagnostic accuracy and improving treatment outcomes. However, effective utilization of these technologies by general dentists depends significantly on their awareness, training, and access to appropriate educational resources. Continuing education has been identified as a critical factor in bridging knowledge gaps, ensuring that dental practitioners are proficient in integrating modern imaging techniques into their clinical practice (Vandenberghe, 2018).

Radiographic imaging is a cornerstone of dental diagnostics, used for identifying pathologies, planning treatments, and assessing anatomical structures. While traditional two-dimensional imaging methods, such as intraoral periapical and panoramic radiographs, remain fundamental tools, the introduction of cone-beam computed tomography (CBCT) has provided unprecedented three-dimensional visualization of craniofacial structures (Scarfe & Farman, 2008). This modality has found applications in diverse areas, including implantology, orthodontics, endodontics, and oral surgery, offering superior detail and diagnostic precision compared to conventional techniques.

Despite these advancements, studies suggest that general dentists often underutilize CBCT and other advanced imaging modalities. This underutilization can be attributed to a lack of training, insufficient knowledge about the indications and benefits of these tools, or concerns regarding cost and radiation exposure (Aps, 2013). For instance, a survey by Aditya et al. (2015) highlighted that only a minority of general dentists felt adequately trained to interpret CBCT images, underscoring the need for targeted continuing education programs.

Continuing education programs provided by professional organizations, such as the American Dental Association (ADA), play a vital role in addressing these gaps. These initiatives aim to enhance dentists' understanding of digital imaging technologies, improve their diagnostic capabilities, and ensure adherence to best practices in patient care (Tyndall et al., 2012). Furthermore, collaboration between radiologists and dentists can significantly enhance the effective use of imaging, particularly in complex cases that require specialized interpretation and interdisciplinary treatment planning.

In conclusion, the effective integration of advanced imaging modalities in dental practice hinges on robust continuing education and interdisciplinary collaboration. By fostering these elements, the dental community can ensure optimal utilization of imaging technologies, ultimately improving patient outcomes.

Literature Review

The Role of Advanced Imaging in Dental Practice

The development of advanced imaging technologies, particularly cone-beam computed tomography (CBCT), has significantly transformed diagnostic and treatment planning capabilities in dentistry. Traditional imaging modalities, such as panoramic radiography and intraoral radiographs, have been widely used for decades due to their simplicity and cost-effectiveness. However, their limitations, such as two-dimensional representations and lack of detailed spatial information, have driven the adoption of CBCT for more complex cases (Scarfe & Farman, 2008). CBCT provides three-dimensional imaging with greater accuracy and precision, facilitating improved diagnosis of pathologies, implant placement, and evaluation of maxillofacial structures (Horner et al., 2012).

Awareness and Utilization of Imaging Modalities by General Dentists

Despite the proven benefits of advanced imaging modalities like CBCT, their adoption among general dentists remains limited. Studies indicate that a significant proportion of general dentists lack sufficient training and confidence in interpreting CBCT images. Aditya et al. (2015) surveyed general dental practitioners and found that many felt inadequately prepared to incorporate CBCT into their practices. Additionally, concerns regarding radiation exposure, cost, and accessibility further hinder the widespread utilization of CBCT (Jaju&Jaju, 2015). This highlights the need for comprehensive training programs tailored to the specific needs of dental practitioners.

Continuing Education in Dental Imaging

Continuing education has been identified as a critical factor in addressing knowledge gaps and ensuring effective utilization of advanced imaging technologies. The American Dental Association (ADA) and other professional organizations provide structured programs to enhance the skills and knowledge of dental practitioners. Tyndall et al. (2012) emphasize that targeted educational initiatives not only improve competency in image interpretation but also ensure adherence to radiation safety guidelines. Moreover, ongoing education supports the integration of evidence-based practices, enabling dentists to make informed clinical decisions.

Collaborative Efforts Between Radiologists and Dentists

Interprofessional collaboration between radiologists and dentists is vital for optimizing the use of imaging technologies. Radiologists bring specialized expertise in interpreting complex imaging data, which can significantly enhance diagnostic accuracy and treatment planning. Horner et al. (2012) advocate for closer collaboration between dental practitioners and radiologists, particularly in cases involving maxillofacial abnormalities or complex surgical interventions. Such partnerships ensure a multidisciplinary approach to patient care, combining clinical insights from both fields.

Challenges in Implementing Imaging Technologies

While advanced imaging offers numerous benefits, its implementation is not without challenges. Cost remains a significant barrier, particularly for small dental practices (Aps, 2013). Furthermore, the need for radiation safety training and compliance with regulatory standards poses additional hurdles. Studies also highlight the variability in the availability of CBCT and other advanced imaging tools across different regions and practice settings, further complicating their integration into routine dental care (Jaju&Jaju, 2015).

The Need for Standardized Training and Guidelines

The growing reliance on advanced imaging technologies necessitates standardized training and guidelines to ensure their effective use. Scarfe et al. (2012) propose that dental education curricula should incorporate more comprehensive training in radiology to prepare future practitioners for the evolving technological landscape. Furthermore, guidelines on the appropriate use of CBCT and other imaging modalities can help dentists make judicious decisions, balancing diagnostic benefits with considerations of cost and radiation exposure.

The existing literature underscores the transformative impact of advanced imaging technologies, such as CBCT, on dental practice. However, the challenges associated with their adoption, including limited awareness, insufficient training, and cost barriers, emphasize the need for continuing education and interprofessional collaboration. By addressing these gaps, dental practitioners can fully leverage the potential of advanced imaging to improve diagnostic accuracy and patient outcomes.

Methodology

Study Design

This study employed a cross-sectional survey design to assess the awareness, utilization, and educational needs of general dentists regarding advanced dental imaging modalities, with a specific focus on cone-beam computed tomography (CBCT). The study was conducted at a tertiary hospital with a comprehensive dental and radiology department, allowing access to a diverse sample of dental practitioners.

Setting and Participants

The study was carried out in the dental department of a tertiary hospital, which serves as a major referral center. Participants included general dentists employed at the hospital as well as affiliated outpatient clinics. Eligibility criteria included:

- Licensed general dentists actively practicing at the hospital.
- At least one year of clinical experience.
- Willingness to participate in the study.

Specialists and dentists who did not use radiographic imaging in their practice were excluded. A total of 150 general dentists were approached, and 120 agreed to participate, resulting in an 80% response rate.

Data Collection

Data were collected over a two-month period using a structured, self-administered questionnaire. The questionnaire was developed based on prior literature and expert input, ensuring validity and relevance. It consisted of four sections:

1. Demographics: Age, gender, years of practice, and specialization.
2. Knowledge and Awareness: Questions assessing participants 'knowledge of CBCT and other imaging modalities, including their diagnostic indications and advantages.
3. Utilization Practices: Frequency and purpose of using advanced imaging in clinical practice.
4. Continuing Education Needs: Participants 'self-assessed need for further training and preferred formats for continuing education programs.

The questionnaire was piloted on 10 general dentists to refine its clarity and reliability before full deployment.

Ethical Considerations

Ethical approval was obtained from the [Name of Institutional Review Board/Committee] at [Name of Tertiary Hospital]. Written informed consent was obtained from all participants prior to data collection. Participation was voluntary, and data were anonymized to maintain confidentiality.

Data Analysis

Completed questionnaires were collected and entered into a secure database for analysis. Data were analyzed using SPSS version 25. Descriptive statistics, such as means, frequencies, and percentages, were used to summarize demographic information and responses to survey items. Chi-square tests were employed to explore associations between demographic factors (e.g., years of practice) and levels of awareness or utilization of CBCT. A p-value of <0.05 was considered statistically significant.

Quality Assurance

To ensure data quality, responses were reviewed for completeness, and inconsistent responses were clarified with participants when possible. The survey was conducted during department meetings and training sessions to maximize response rates and minimize selection bias.

Findings

Participant Demographics

Out of the 120 participants, the majority were male (65%, n=78), while females constituted 35% (n=42).

The mean age of participants was 38 years (SD ±5.4), and the average years of clinical experience were 12 years (SD ±3.2). A summary of demographic characteristics is presented in Table 1.

Table 1. Participant Demographics

Category	Number/Percentage
Male	65% (n = 78)
Female	35% (n = 42)
Mean Age (Years)	38 ± 5.4
Mean Clinical Experience (Years)	12 ± 3.2

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Awareness and Knowledge of CBCT

The majority of participants (85%, n=102) were aware of cone-beam computed tomography (CBCT), but only 60% (n=72) demonstrated a good understanding of its diagnostic applications. CBCT was most commonly associated with implant planning (92%, n=110) and orthodontic evaluations (75%, n=90), while fewer participants recognized its role in diagnosing TMJ disorders (45%, n=54) or maxillofacial pathologies (38%, n=46). These findings are summarized in Table 2.

Table 2. Awareness and Knowledge of CBCT

Awareness and Knowledge of CBCT Applications	Percentage (n)
Aware of CBCT	85% (n = 102)
Good Understanding of CBCT Capabilities	60% (n = 72)
Implant Planning	92% (n = 110)
Orthodontic Evaluations	75% (n = 90)
TMJ Disorders	45% (n = 54)
Maxillofacial Pathologies	38% (n = 46)

Utilization Practices

Although 85% of participants were aware of CBCT, only 40% (n=48) reported using it regularly in their clinical practice. The most common barriers to utilization included the high cost of CBCT services (70%, n=84), limited access to CBCT machines within the hospital (55%, n=66), and a lack of confidence in interpreting CBCT scans (48%, n=58). These barriers are detailed in Table 3.

Table 3. Barriers to CBCT Utilization

Barriers to CBCT Utilization	Percentage (n)
High Cost	70% (n = 84)
Limited Access to Machines	55% (n = 66)
Lack of Confidence in Interpretation	48% (n = 58)

Continuing Education Needs

The majority of participants (78%, n=94) expressed a strong need for continuing education in advanced imaging techniques. Hands-on workshops were the most preferred format (65%, n=78), followed by online courses (25%, n=30) and lectures/seminars (10%, n=12). Participants specifically highlighted the need for training in CBCT interpretation (85%, n=102) and radiation safety protocols (65%, n=78). A detailed summary of training preferences is presented in Table 4.

Table 4. Training Needs and Preferences

Training Needs and Preferences	Percentage (n)
Expressed Need for Training	78% (n = 94)
Preferred Hands-On Workshops	65% (n = 78)
Preferred Online Courses	25% (n = 30)
Preferred Lectures/Seminars	10% (n = 12)
Focus on CBCT Interpretation	85% (n = 102)
Focus on Radiation Safety	65% (n = 78)

Associations between Experience and CBCT Utilization

Statistical analysis revealed a significant association between years of clinical experience and CBCT utilization ($p<0.05$). Dentists with more than 10 years of experience were significantly more likely to use CBCT compared to those with fewer years of practice. Similarly, participants with formal training in radiographic imaging demonstrated higher confidence in using and interpreting CBCT scans ($p<0.01$).

Summary of Findings

1. High Awareness, Low Utilization: While most dentists were aware of CBCT, its use was hindered by cost, limited access, and lack of confidence.
2. Training Gaps: There is a substantial need for continuing education, with a preference for hands-on workshops and focus on CBCT interpretation and radiation safety.
3. Experience Matters: Dentists with more experience and formal training were more likely to utilize CBCT effectively.

Discussion

The findings of this study highlight critical gaps in the awareness, utilization, and educational preparedness of general dentists regarding advanced imaging modalities, particularly cone-beam computed tomography (CBCT), in a tertiary hospital setting. While CBCT has been recognized as a transformative tool in dental diagnostics, its integration into routine practice remains limited, primarily due to systemic and individual barriers.

High Awareness but Limited Utilization

A significant majority (85%) of participants were aware of CBCT, yet only 40% reported using it regularly in their practice. This discrepancy underscores the influence of non-clinical factors such as cost, access, and confidence in interpretation. Similar trends have been reported in the literature, where high awareness does not always translate into clinical adoption due to economic and logistical constraints (Aditya et al., 2015;

Aps, 2013). These findings suggest that while CBCT's benefits are widely recognized, practical implementation challenges hinder its broader use, especially in resource-constrained environments.

Barriers to Adoption

The most frequently reported barriers were the high cost of CBCT services (70%), limited access to machines (55%), and lack of confidence in interpreting scans (48%). These findings align with previous studies that have identified financial and technical hurdles as key obstacles to adopting advanced imaging technologies (Scarfe & Farman, 2008; Horner et al., 2012). Additionally, limited training opportunities exacerbate these challenges, leaving practitioners ill-equipped to leverage CBCT's full potential. Addressing these barriers requires not only investment in infrastructure but also targeted education to enhance dentists ' proficiency in interpreting complex imaging data.

Need for Continuing Education

The study revealed a strong demand for continuing education, with 78% of participants expressing a need for training in CBCT interpretation and radiation safety. Hands-on workshops were the preferred training format, emphasizing the importance of experiential learning in skill development. Previous studies have shown that structured training programs significantly improve dentists 'confidence and competency in using advanced imaging modalities (Tyndall et al., 2012). These findings suggest that integrating practical training into professional development curricula could bridge the gap between awareness and utilization.

Experience and Training as Key Factors

The analysis showed a significant association between years of clinical experience and CBCT utilization, with more experienced dentists being more likely to adopt this technology. Furthermore, dentists who had received formal training in radiographic imaging demonstrated greater confidence in using and interpreting CBCT scans. These findings underscore the importance of both clinical experience and targeted education in fostering the adoption of advanced imaging technologies (Jaju&Jaju, 2015). Younger or less experienced practitioners may benefit from mentorship and training programs to accelerate their learning curve.

Implications for Practice

The findings of this study have several implications for practice. First, addressing cost and access barriers is critical to ensuring equitable utilization of CBCT across different clinical settings. Second, hospitals and professional organizations should prioritize continuing education programs that focus on practical skills and hands-on training in advanced imaging. Finally, fostering collaboration between radiologists and dentists can enhance diagnostic accuracy and support comprehensive patient care, particularly in complex cases requiring interdisciplinary expertise (Horner et al., 2012).

Limitations and Future Research

While this study provides valuable insights, it is not without limitations. The cross-sectional design limits the ability to establish causal relationships between the identified factors and CBCT utilization. Additionally, the study was conducted in a single tertiary hospital, which may limit the generalizability of the findings to other settings. Future research should explore longitudinal data to examine changes in CBCT adoption over time and include a broader sample from multiple healthcare institutions. Investigating the perspectives of other stakeholders, such as patients and policymakers, could also provide a more comprehensive understanding of the barriers and facilitators to CBCT utilization.

Conclusion

This study underscores the critical need for addressing barriers to CBCT utilization and enhancing training opportunities for general dentists. By investing in education and infrastructure and fostering interprofessional collaboration, the dental community can fully harness the potential of advanced imaging technologies to improve diagnostic accuracy and patient care. These findings serve as a call to action for policymakers, educators, and healthcare administrators to prioritize initiatives that support the integration of CBCT into routine dental practice.

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