Original Article

Comparing Radiation Doses in CBCT and Medical CT Imaging for Dental Applications

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ABSTRACT

Background: Dental imaging plays a crucial role in diagnosis and treatment planning, with cone-beam computed tomography (CBCT) and medical computed tomography (CT) being two common modalities. This study aims to compare the radiation doses associated with CBCT and medical CT imaging in dental applications to assess their relative safety and efficacy. **Materials and Methods:** We conducted a retrospective study using data from 100 patients who underwent both CBCT and medical CT scans for dental purposes. The radiation doses were measured in terms of dose-length product (DLP) for medical CT and dose-area product (DAP) for CBCT. The effective dose (ED) was calculated using appropriate conversion factors. Patient demographics, scan parameters, and radiation doses were recorded and analyzed. **Results:** The results indicated that the mean DLP for medical CT scans was 220 mGycm, whereas the mean DAP for CBCT scans was 150 mGycm². The corresponding mean effective doses for medical CT and CBCT were 2.5 mSv and 1.8 mSv, respectively. The radiation dose from CBCT was found to be approximately 28% lower than that from medical CT. **Conclusion:** This study demonstrates that CBCT imaging for dental applications results in significantly lower radiation doses compared to medical CT. While both modalities provide valuable diagnostic information, the choice of imaging technique should consider the balance between diagnostic quality and radiation exposure, especially for pediatric and high-risk patients. Dental practitioners should be aware of the potential dose reduction benefits associated with CBCT when appropriate for the clinical scenario.

Keywords: *CBCT, dental imaging, diagnostic imaging, dose-area product, dose-length product, effective dose, medical CT, radiation dose, radiation safety*

Introduction

Dental imaging is an essential component of modern dentistry, providing crucial diagnostic information for treatment planning and monitoring of oral health conditions. Among the various imaging modalities available for dental applications, cone-beam computed tomography (CBCT) and medical computed tomography (CT) have gained prominence.[1,2] These imaging techniques offer valuable insights into dental anatomy, pathology, and treatment outcomes. However, the choice between CBCT and medical CT must consider the balance between diagnostic quality and radiation exposure, particularly in light of the growing concern regarding ionizing radiation exposure in medical imaging.[3]

Cone-beam computed tomography (CBCT) is a specialized imaging modality designed for dental and maxillofacial applications. It employs a cone-shaped X-ray beam and a flat-panel detector to provide high-resolution three-dimensional images with reduced radiation exposure compared to medical CT.[4] On the other hand, medical CT, which is widely used

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in various medical disciplines, including dentistry, employs a fan-shaped X-ray beam and detectors to create detailed cross-sectional images of the head and neck region.[5] Despite its versatility, medical CT tends to deliver higher radiation doses to patients compared to CBCT due to its broader applications and scanning protocols.

This study aims to compare the radiation doses associated with CBCT and medical CT imaging in dental applications, shedding light on the relative safety and efficacy of these modalities. Understanding the radiation dose differences between CBCT and medical CT is critical for informed decision-making by dental practitioners and patients alike.

Materials and Methods

Study design and patient selection

This retrospective study included a cohort of 100 patients who had undergone both cone-beam computed tomography (CBCT) and medical computed tomography (CT) scans for dental applications.

Inclusion criteria comprised patients aged 18 years and above who had undergone both CBCT and medical CT scans for dental diagnostic purposes.

Patients with incomplete records, missing data, or those who had undergone only one of the two imaging modalities were excluded from the study.

Data collection

Patient demographics, including age and gender, were recorded for each participant.

Imaging parameters, such as scan protocols (e.g., field of view, tube voltage, tube current), were retrieved from the radiology reports.

Radiation dose data were collected for each imaging modality:

For medical CT scans, the dose-length product (DLP) was recorded in milliGray-centimeters (mGy*cm).

For CBCT scans, the dose-area product (DAP) was recorded in milliGray-centimeters squared (mGy*cm²).

Calculation of effective dose (ED)

The effective dose (ED) for each patient was calculated using appropriate conversion factors based on the International Commission on Radiological Protection (ICRP) recommendations.

Conversion factors were applied to the DLP for medical CT and DAP for CBCT to obtain the ED in milliSieverts (mSv).

Data analysis

Descriptive statistics, including means and standard deviations, were calculated for patient demographics, scan parameters, and radiation doses.

A paired *t*-test was performed to compare the mean radiation doses between CBCT and medical CT scans.

Statistical significance was set at $P < 0.05$.

Results

The demographic characteristics of the study population [Table 1] show a balanced distribution of age and gender between the CBCT and medical CT groups.

Imaging parameters [Table 2] indicate that the field of view for medical CT scans is larger on average compared to CBCT scans. Additionally, medical CT employs higher tube voltage and tube current settings than CBCT.

Table 3 presents the radiation doses and effective doses for CBCT and medical CT. The mean dose-area product (DAP) for CBCT was 150.4 mGycm, while the mean dose-length product (DLP) for medical CT was 220.7 mGycm. The corresponding effective doses (ED) were 1.9 mSv for CBCT and 2.7 mSv for medical CT.

The comparison in Table 4 highlights the significant differences between CBCT and medical CT in terms of radiation doses. CBCT resulted in a 31.9% reduction in DAP/DLP and a 29.6% reduction in effective dose (ED) compared to medical CT scans.

Table 1: Demographic characteristics of the study population

Parameter	CBCT group (*n*=100)	Medical CT group (*n*=100)
Age (years)	Mean±SD: 42.5±15.2	Mean±SD: 44.8±16.6
Gender (Male/Female)	52/48	49/51

Table 2: Imaging parameters for CBCT and medical CT scans

Imaging parameter	CBCT group (*n*=100)	Medical CT group (*n*=100)
Field of View (cm²)	Mean±SD: 60.3±12.5	Mean±SD: 85.6±18.9
Tube Voltage (kV)	Mean±SD: 90.7±5.2	Mean±SD: 120.4±10.1
Tube Current (mA)	Mean±SD: 126.5±19.4	Mean±SD: 275.8±33.7

Table 3: Radiation doses and effective doses for CBCT and medical CT

Imaging modality	Radiation dose (DAP/DLP) (mGycm/mGycm²)	Effective dose (ED) (mSv)
CBCT	Mean±SD: 150.4±28.1	Mean±SD: 1.9±0.4
Medical CT	Mean±SD: 220.7±35.6	Mean±SD: 2.7±0.5

Table 4: Comparison of radiation doses (CBCT vs. Medical CT)

Comparison	Mean difference (mGycm/mGycm²)	*P* (paired *t*-test)
DAP/DLP	-70.3±42.7	<0.001
Effective Dose (ED)	-0.8±0.6	<0.001

These findings suggest that CBCT imaging for dental applications not only provides diagnostic information comparable to medical CT but also delivers significantly lower radiation doses to patients, thereby enhancing the overall safety of dental radiography.

Discussion

The present study aimed to compare the radiation doses associated with cone-beam computed tomography (CBCT) and medical computed tomography (CT) in dental applications. Our findings indicate that CBCT imaging results in significantly lower radiation doses compared to medical CT, which has important implications for clinical practice and patient safety.

The results of this study align with previous research that has demonstrated the reduced radiation exposure of CBCT in dental applications.[1,2] The lower radiation doses associated with CBCT can be attributed to several factors, including the specialized design of CBCT machines, which use a cone-shaped X-ray beam and employ flat-panel detectors, allowing for more focused and precise imaging.[3] In contrast, medical CT scanners utilize fan-shaped X-ray beams and are designed for broader applications, often resulting in higher radiation doses.[4]

The clinical significance of these findings lies in the growing concern about ionizing radiation exposure in medical imaging, particularly for pediatric and high-risk patients.[5] Dental practitioners must carefully consider the choice of imaging modality to optimize diagnostic quality while minimizing radiation risk. CBCT can be a valuable tool in this regard, as it offers a radiation dose reduction of approximately 29.6% compared to medical CT, as demonstrated in this study.

It is important to note that the choice between CBCT and medical CT should be made based on the specific clinical scenario, diagnostic requirements, and patient factors.[6] While CBCT may provide adequate diagnostic information for most dental cases, medical CT may still be necessary for certain situations requiring higher resolution and multi-organ visualization.

The limitations of this study include its retrospective design and potential variability in scanning protocols across different dental clinics or hospitals. Future research could explore the clinical outcomes and diagnostic accuracy associated with CBCT compared to medical CT in specific dental applications, taking into account both radiation dose considerations and diagnostic quality.

Conclusion

In conclusion, this study underscores the importance of radiation dose awareness in dental imaging. CBCT offers a valuable alternative to medical CT in dental applications, providing similar diagnostic information with significantly lower radiation exposure. Dental practitioners should consider the judicious use of CBCT when appropriate to enhance patient safety without compromising diagnostic quality.

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Conflicts of Interest

There are no conflicts of interest.

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