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Clinical Applications Of Cone Beam Computed Tomography (Cbct) In The Evaluation Of Dental Implants: A Literature Review

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Abstract:
Cone Beam Computed Tomography (CBCT) has changed the future for implant applications, providing in-depth 3D scans with much lower doses of radiation. CBCT as pre-and postoperative assessment enables clinicians to make highly accurate implant planning and placement. Unlike conventional CT scanners, this system offers several benefits, cost efficiency, compactness, and fine spatial resolution. Associated complications include removing of metal artifacts and the management of radiation dose. Continuous development is ongoing, aiming to improve image quality and dose reduction. AI in dentistry brings its transformation success with CBCT, offering more efficient diagnosis as well as personalized treatment
***Key Word**: Cone Beam, Computed Tomography, Dental Implants.*

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I. Introduction.

Dental implants are an essential treatment modality for replacing a missing or decayed tooth, with a success rate of 97% for more than 10 years (Gupta et al., 2023). Hence, implants have better performance than fixed partial dentures, in addition to advantages such as such the reduction of dental caries and endodontic problems in neighboring teeth, the preservation of adjacent bone tissue in edentulous areas, and less pain for neighboring teeth. After so many innovations, implant dentistry has become highly advanced and is now navigated by precise anatomical considerations and advanced surgical techniques. Collaboration among dental professionals ensures the success of implant-retained restorations. Preoperative preparation involves meticulous attention to detail and utilizing radiographs for comprehensive assessment before surgery. After careful preoperative and postoperative care, the success rate becomes higher to 85% in 5 years and 80% in 10 years. Cone Beam Computed Tomography (CBCT) technologies innovation geared towards dental procedures (Gupta et al., 2023). Breakthrough in medical science's history is modernization of the diagnostic capacities and accurate pathology diagnosis and treatment by the discovery of X-rays by Wilhelm C. Röntgen in 1895 (Medscience, 2024). Nevertheless, the acknowledgment of the potential of X-rays in dentistry occurred 14 years after their discovery, and Dr. Walkhoff in Braunschweig, Germany, became one of the pioneers. The delay in acknowledging the X-rays use in dentistry hindered the improvement of scientific evaluating procedures, like the development of cone beam computed tomography (CBCT).

CBCT, is the modern evolution of CT scan invented by British engineer Godfrey Hounsfield in 1967, was initially intended for radiotherapy and angiography procedures. Ready-to-use CBCT products appeared in Europe in 1998 and the US in 2001. In the late 80's and early 90s, CBCT started to come up in the literature. In Columbia Scientific Inc., introduced 3D dental software (Shukla et al., 2017). In dentistry, CBCT was introduced as a significant improvement that allowed clinicians to acquire an in-depth understanding of the pathologic process and finally access the 3-dimensional views of intricate underlying structures. This groundbreaking innovation streamlined the process and aided in correct critical viewing of the bony defects from different angles. CBCT application postponement by the dental profession in the past for prolonged periods indicates that the profession had missed this excellent opportunity to implement advanced diagnostic technology earlier in dentistry (Shukla et al., 2017).

Cone beam computed tomography (CBCT) is a high-tech, three-dimensional (3D) imaging method for the complex structures, represented by imaging with sub-millimeter resolution, and a shorter scanning period of about 4 to 40 seconds (Venkatesh & Elluru, 2017). Contrasting with conventional CT scanning, CBCT decreases radiation dose (about ten times less) during the diagnosis of maxillofacial structures (68 µSv versus 600 µSv). It exhibits remarkable depth of field, with a progressive magnification of only about 2%. CBCT is frequently being used diagnostic imaging technology by dental clinicians with safe and accurate 3D model views of the affected part of the maxillofacial structures while simultaneously lowering radiation hazards and distortion (Kumar et al., 2015).

Including CBCT machines in different functional dental implant-related applications like treatment planning, surgical planning, and guidance systems stems from cost-effectiveness, compact size, and the precise 3D visualization of complex tissue structures. This recent imaging modality covers bone quality and quantity evaluation and accurately analyzes the anatomic structures. With the help of AI, CBCT gives precise implant placement planning while evaluating and proper guiding the post-implant treatment. CBCT gives high-resolution images with limited distortion. Radiations exposure is minimal compared to CT scan or other conventional techniques (Bromberg & Brizuela, 2023).

II. Material And Methods.

Inclusion and Exclusion Criteria

We selected peer-reviewed articles published in English within the last ten years to keep it current while ensuring the latest technology is being discussed; studies that precisely assess the use of CBCT in the evaluation of dental implants; systematic or meta-analysis or other cohort studies that discuss clinical outcomes, comparative analyses with other imaging modalities, AI use, and technical assessments of CBCT.

Studies focusing on using CBCT in areas other than dental implantology were excluded. Non-peer-reviewed literature, such as editorials, opinion pieces, and case reports, with insufficient data were also excluded.

Search Strategy

We designed to start our research on PubMed and Scopus. Search Terms and Syntax were designed with broader and more specific approaches to find all matching studies. We used Boolean operators (AND, OR, NOT) to dial in the search. Our primary search term was ("Cone Beam Computed Tomography" OR CBCT)) AND ("dental implants" OR "implantology"), which was used with other terms.

Screening and Selection process

To perform the preliminary review of the records based on title and abstract, leading to the elimination of irrelevant studies, we accessed full-text articles, and papers were selected based on inclusion and exclusion criteria. We detailed and structured our findings, resembling PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

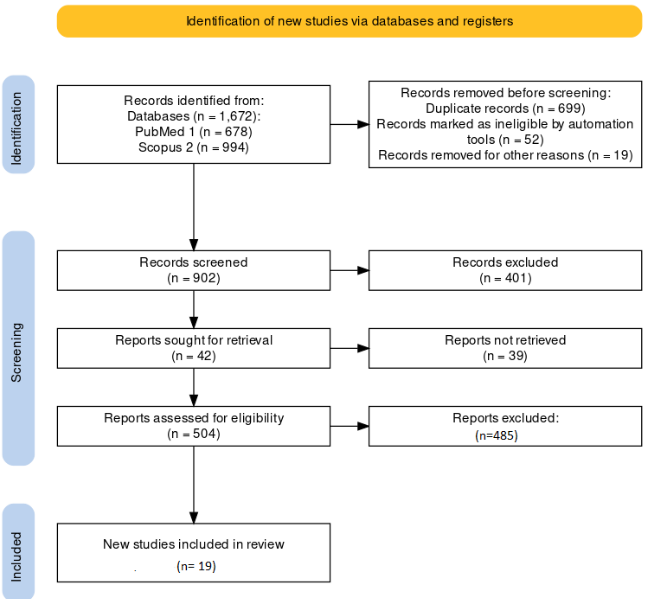

Figure 1. Flowchart Diagram for PRISMA

III. Result

Our systematic search across two databases yielded 1672 potentially relevant studies initially. After sifting through duplicates and conducting an initial screening based on titles and abstracts, 902 records were examined. Ultimately, 401 studies were excluded for various reasons, such as irrelevance to the research question, lack of clinical data, irrelevant papers, study design or quality issues, and language barriers. 504 papers were selected for eligibility and out of which, 485 were further removed. Consequently, 19 studies were included in the review, providing a comprehensive understanding of CBCT's clinical application in dental implant evaluation, including its effectiveness, advantages, limitations, and potential areas for further research.

Author Names	Year	Results Findings
1. Bornstein, M. M., Scarfe, W. C., Vaughn, V., & Jacobs, R.	2014	A systematic review of CBCT in implant dentistry: 12 publications offer guidelines, 43 articles discuss indications and contraindications, and 22 articles address radiation dose risks. CBCT aids pre- and postoperative assessment, with varied, effective doses and the potential for a significant reduction.
2. Bromberg, N., & Brizuela, M.	2023	Cone beam computed tomography (CBCT) scanners offer several advantages over traditional CT scanners in dentistry. They are cost-effective, compact, and have superior spatial resolution. Unlike CT scanners, CBCT scanners do not require specific environmental conditions, extensive electrical requirements, or structural modifications. They provide detailed 3D scans with minimal radiation exposure, benefiting various dental specialties. However, their use should be justified based on risk-benefit analysis for optimal patient care.
3. Brüllmann, D., & Schulze, R.	2015	Brüllmann et al., review focuses on spatial resolution in Cone Beam Computed Tomography (CBCT) for dental/maxillofacial applications. It discusses assessment parameters such as line-pair measurements and modulation transfer function (MTF). Published data suggests CBCT images have effective spatial resolutions ranging from 0.6 to 2.8 lp mm^{-1}, influenced by various factors, with a realistic resolution of just above one lp mm^{-1} in clinical settings.
4. De Oliveira Pinto, M. G. et al.	2021	The study examines the influence of tooth position within the field-of-view (FOV) on cone-beam computed tomography (CBCT) imaging artifacts when evaluating teeth with various intracanal materials. Results indicate that artifact intensity increases with high atomic number materials and when objects are not centered within the FOV. Specifically, fiberglass posts cemented with core build-up dual-curing cement show a more significant impact from positioning within the FOV than other materials.
5. Dhopte, A., & Bagde, H.	2023	The author discusses the transformative potential of artificial intelligence (AI) in dentistry. AI offers opportunities to revolutionize clinical practice by enhancing diagnosis, treatment planning, image analysis, patient management, and personalized care. Challenges such as data privacy and algorithm bias must be addressed, but collaborative efforts can ensure responsible implementation. AI-driven robotics and virtual reality applications further augment dental surgery and education. AI promises to improve dental practice, leading to more efficient, precise, and patient-centric oral healthcare.
6. Gupta, R., Gupta, N., & Weber, K. K., DDS	2023	Dental implants are integral for replacing missing teeth. They boast a success rate exceeding 97% over 10 years, decreasing risks of adjacent tooth caries and endodontic issues. They also improve bone maintenance and reduce sensitivity in adjacent teeth. Implants comprise alloplastic materials providing support for dental prostheses.
7. Johari, M. et al.	2018	The study addresses metal artifacts in dental cone beam computed tomography (CBCT) images, proposing a new artifact reduction algorithm. It comprises three parallel components: teeth extraction based on Gaussian mixture modeling, artifact reduction through polar domain conversion and morphological filtering, and cavity filling via morphological operations. Results demonstrate significant artifact reduction, yielding visually improved and clinically applicable CBCT images.
8. Medscience, O.	2024	X-rays, discovered in 1895 by Wilhelm Conrad Roentgen, are vital in science and medicine due to their ability to penetrate substances. They revolutionized medical diagnostics, allowing non-invasive examination of internal structures while finding applications in industries and scientific research. Technological advancements have continually improved X-ray imaging, enhancing safety and precision.
9. N, K. K. et al.	2021	The systematic review compares magnetic resonance imaging (MRI) and cone beam computed tomography (CBCT) in diagnosing periapical pathosis. While CBCT is established, MRI is a concept. Reviewing 19 articles, it suggests combined MRI and CBCT usage for precise diagnosis due to MRI's soft tissue imaging capability and CBCT's risk of overdiagnosis.
10. Nasseh, I., & Al-Rawi, W.	2018	In recent decades, dentistry's demand for 3-dimensional imaging has surged. While computed tomography (CT) enabled such imaging, it remained hospital-based, expensive, and radiation-intensive. The late 90s saw the emergence of cone beam computed tomography (CBCT), revolutionizing 3D perception in dentistry. CBCT, utilizing extraoral scanners, provides 3D scans of the maxillofacial skeleton, offering comparable size to panoramic radiographic machines. Unlike CT, CBCT employs a cone-shaped beam and 2D planar detectors, irradiating a more significant volume area for imaging.

11. Pauwels, R. et al.	2015	This review emphasizes the importance of understanding the technical aspects of cone beam computed tomography (CBCT) in dental and maxillofacial imaging. It covers hardware overview, cone beam image acquisition, reconstruction principles, imaging protocol optimization, and visualization methods. While some topics are relevant to all radiographic imaging, others are specific to dental CBCT. Future developments may enhance CBCT's image quality and broaden its application range, with innovations in detector materials, X-ray tube technology, and reconstruction algorithms expected to improve image quality and reduce radiation dose.
12. Pauwels, R. et al.	2015	The article investigates the suitability of Hounsfield units (HUs) in cone beam computed tomography (CBCT) for assessing bone quality, particularly for implant planning in dentistry. CBCT's limitations, including variability in gray values (GVs) due to technique-specific factors like limited field size and scattered radiation, caution against quantitative GV use. Recent research suggests a shift towards structural evaluation of bone quality, enabled by CBCT's improving image quality, potentially allowing the application of micro-CT and histology-based structural analysis methods.
13. Shin, H. S. et al.	2014	Effective doses from various CBCT modes were compared with panoramic radiography in adult and child settings. Doses were calculated using conversion formulae from dose area product meter measured values, considering tube voltage. Maximum effective doses from Alphard 3030 and Rayscan Symphony CBCT were 67 and 21 times greater than panoramic radiography. Ratios of effective dose under child setting to adult condition ranged from 0.60 to 0.95. Maximum differences between adult and child exposure settings were 27 and 4 times greater than panoramic radiography in Alphard 3030 and Rayscan Symphony, respectively.
14. Shukla, S., Chug, A., & Afrashtehfar, K. I.	2017	Effective doses from various CBCT modes were compared with panoramic radiography under adult and child settings, using conversion formulae from dose area product meter measured values. Maximum effective doses from Alphard 3030 and Rayscan Symphony CBCT were 67 and 21 times greater than panoramic radiography. Ratios of effective dose under child setting to adult condition ranged from 0.60 to 0.95. Maximum differences between adult and child exposure settings were 27 and 4 times greater than panoramic radiography in Alphard 3030 and Rayscan Symphony, respectively. This review concludes that CBCT effective doses were significantly higher than panoramic radiography, emphasizing the importance of minimizing exposure, especially in children.
15. Urban, R. et al.	2023	This paper reviews how AI will transform dental practices, focusing on CBCT data management and the evolving role of dental assistants. It discusses AI's potential benefits in streamlining diagnostic workflows, particularly in automated CBCT segmentation. However, it notes limitations due to bias risks in studies. Overall, AI offers promise in enhancing efficiency and accuracy in dental workflows but requires further research and development.
16. Venkatesh, E., & Elluru, S. V.	2017	CBCT technology revolutionized oral and maxillofacial radiology with its compact size, affordability, and three-dimensional imaging capabilities.
17. Li, G.	2013	The paper highlights the significant differences in patient radiation doses between CBCT and helical CT, with CBCT resulting in much lower doses. It emphasizes the direct correlation between patient radiation dose and the field of view (FOV) and exposure parameters in CBCT, with larger FOVs leading to higher doses. Furthermore, CBCT's effective dose surpasses conventional dental radiography several to hundreds of times. It underscores the importance of tailoring CBCT scanning protocols to specific diagnostic tasks to minimize patient dose. Additionally, the paper advocates using a thyroid collar during CBCT scanning and suggests wearing leaded glasses, provided they do not compromise imaging quality, for further dose reduction.
18. Spin-Neto, R. et al.	2011	Spin-Neto et al.'s study investigates the use of CBCT for assessing bone grafts in the maxillofacial region, highlighting a need for more standardization in image generation and analysis methods. Despite CBCT's potential reliability, the study finds that crucial information regarding image acquisition and reconstruction needs to be included in published papers, compromising reproducibility and scientific impact.
19. Orentlicher, G., Goldsmith, D., & Abboud, M.	2012	The article discusses computer-guided planning and placement of dental implants, emphasizing the importance of a team approach and the use of 3D diagnostic and treatment planning technologies. It highlights the ability to start with the desired outcome and accurately place implants based on computer-generated virtual treatment plans, resulting in improved patient care and outcomes through interdisciplinary communication.

Table 1. Summary of Findings

CBCT Technology and Principles

Conventional CT scanners employ a fan-shaped X-ray beam to capture images in slices or through continuous spiral motion. In CBCT, the detection area is imparted with the cone-shaped beam from the source and then spun around the patient in a single scanning motion along with the solid-state flat panel detector to cover the targeted anatomical volume. This procedure brings down the absorbed dose by X-rays by a large margin. The CT scans produce 2D images similar to lateral cephalometric films where every marginal-to-marginal image is slightly shifted from the previous image. The advantage of CBCT goes beyond the stacked axial slices provided by CT scans and clear X-rays for a single rotation, which reduces the scanning time and X-ray exposure. Cone Beam Computed Tomography (CBCT) shares some similarities in X-ray parameters with panoramic radiography, such as the milliampere (mA) and kilovoltage peak (kVp) settings _more akin to those used in CT scanning rather than conventional X-ray imaging. CBCT captures 2D images using a cone-shaped X-ray beam, similar to panoramic radiography, but then CBCT is designed to reconstructs these images into a 3D anatomical volume, which is than viewed in different planes, including axial, coronal, and sagittal, allowing for detailed examination and treatment planning. The data obtained from CBCT scans is typically saved in DICOM format, which is a standard medical imaging format and it is useful because it allows easy exchange of information and compatibility with various imaging software platforms. (Spin-Neto et al., 2011). Most CBCT devices come with simple view menus and basic 3D imaging features. Another function that can be performed with CBCT is ray summing that allows for visualization of dense structures and volumetric reconstructions.

Clinical Applications of CDCT Over Traditional Techniques

Unlike a 2D imaging, the CBCT provides 3D images of the region, providing very high-resolution 3D imaging of anatomical structures and pathological alterations making it possible to diagnose teeth problems and plan treatment courses more accurately. Various CBCT equipment emerged from the original technology, offering reduced radiation dose crucial for dentistry, compared to traditional CT scans. (Li, 2013). A CBCT systemic review reveals vital facts about the qualification of the technique in implant dentistry. Clinical guidelines on CBCT use in implant treatment were drawn from 12 peer-reviewed studies. Neurovascular complications drove complications in CBCI usage, especially in preoperative analysis. CBCT scans showed substantially lower effective doses, around 100 times less at maximum settings. Most of the adjustments are needed in surgical conditions _viewing or radiation dose factors to minimize errors (Bornstein et al., 2014). CBCT scanners, when compared to these CT counterparts, are quite affordable and frequently available for advanced imaging more realistic in dental practices (Pauwels et al., 2015) (Nasseh & Al-Rawi, 2018).

CBCT scanning is more straightforward and quicker, offering a full range of imaging in just 5 to 40 seconds, rotating around the head and capturing 360 images. These continuous examinations minimize the possibility of image heat-up due to patient movements and cause more comfort (Venkatesh & Elluru, 2017). CBCT scanners help attain better spatial resolution through small pixel sizes so that engineering the depiction in detail of the tiny dental structures is possible. Such precise diagnosis and treatment planning, including implantology, endodontics, and orthodontics, fall within the range of this high resolution (Brüllmann & Schulze, 2015). The CBCT makes it possible to select and change the FOV sizes, which allows the producers to select the view competently in area of interest. The developed hardware essentially takes X-ray imaging to the next level by cutting unneeded radiation and also improving image quality according to a particular diagnostic mission (De Oliveira Pinto et al., 2021).

CBCT Limitations And Challenges

CBCT also has issues with lower contrast than common radiographic ways, such as intraoral or panoramic radiography. Ultimately, it may lead to the overlap or, hence, non-visualization of certain anatomical or pathological features (Venkatesh & Elluru, 2017). Though CBCT tends to be a better option in terms of radiation dose in comparison to C-arm CT, it may still have a higher dose compared to Digitized Radiography, e.g., it is seen about 10 times higher radiation exposure compared to Intraoral and Panoramic radiographic techniques in dentistry (Shin et al., 2014). CBCT has a lower chance of finding soft tissue diseases like CT or MRI, which are of medical grade. Moreover, CBCT only gives limited information on the localization of these masses and does not allow for distinguishing between tumor margins such as in case of ameloblastoma or odontogenic tumors, CBCT do not distinguish boundaries or the contrast between soft tissues, making it unsuitable for specific diagnostic tasks such as evaluating soft tissue masses or malignancies in tooth.

While the diagnosis utility of MRI and CBCT is the same, and sometimes both are needed for accurate diagnosis, the main difference is that MRI is able to identify soft tissues more clearly by using nonionizing radiation, and sometimes CBCT overdiagnoses lesions, which is a major limitation of CBCT (N et al., 2021). The presence of metallic cases often restricts the scanning area in CBCT imaging, resulting in the construction of artifacts. This artifact can manifest itself as dark stains or radiolucencies of a sort similar to the shades of the teeth, thus making caries indistinguishable from actual caries or imitating caries without their presence (Johari et al., 2018). Unlike a CT scan, CBCT is not seen in bone density measurement directly in the Hounsfield unit (HU) points which could be a critical limitation in various conditions, for instance, in implantology where we need precise bone density measurement. There are modalities available, designed to interconvert CBCT values with an approximation of HU, but accuracy of such conversions should be ensured to accurate (Pauwels et al., 2015). Using a small field of view (FOV) in CBCT may cause voxel instability, it is because FOV diameter is mostly smaller than patient's head, so this limitation can make acquiring a complete set of image data challenging, impacting the mathematical accuracy of CT values used for image reconstruction (Tayman et al., 2022).

Preimplant Evaluation: Diagnostic Considerations

For implant placement in an edentulous area, CBCT will whether the spot is suitable for implant, which is done through multiplanar reformatting which is proprietary software supplementary to CBCT scanners that give different angles views and planes, ultimately analyzing and planning implant placement. These reconstructions encompass various views, such as panoramic, cross-sectional, sagittal, and more, providing comprehensive images of the intended implant site. These images, customizable in size and thickness according to user preference, are easily generated through user interaction with the volumetric data at hand. Once generated, measurement tools facilitate assessments of alveolar bone height, width, and angles, aiding in selecting the appropriate fixture size and insertion path. Concerns may arise regarding the precision of measurements of CBCT but CBCT manufacturers integrate sophisticated mathematical algorithms post-image capture. This ensures that the data displayed on the screen are adjusted perfectly for magnification, resulting in highly accurate measurements with no errors across most CBCT scanners (Angelopoulos & Aghaloo, 2011). Dental implants are placed near critical anatomical structures in the jaw, such as the mandibular canals, mental foramina, submandibular gland fossae, neighboring teeth in the mandible, and the maxillary sinuses, nasal cavity, nasopalatine canal, and neighboring teeth in the maxilla. Traditional dental image techniques like panoramics and intraoral views may not adequately visualize these complex structures, especially the maxillary sinuses, nasal cavities, and nasopalatine canals (Angelopoulos & Aghaloo, 2011).

To overcome this limitation, dental practitioners utilize cone beam computed tomography (CBCT), which provides detailed cross-sectional images by slicing areas into sections. CBCT enables easy identification of undercuts in the alveolar bone, which can affect the feasibility of implant placement. Depending on their size, these undercuts may limit or compromise the success of the implant procedure and provide risk assessment. CBCT provides a clearer depiction of anatomical structures such as the mandibular canals. Multiplanar reformatting allows views at different angles, improving the detection of the canal even if it is lightly corticated. Tracing the path of the inferior alveolar nerve in the canal helps clinicians plan implant placement near the canal more accurately (Angelopoulos & Aghaloo, 2011).

CBCT scans are crucial for assessing alveolar bone quality for dental implants, offering detailed insights into thickness, continuity, and density. While interpreting CBCT data can be challenging due to variability, these scans are invaluable for detecting pathology, evaluating grafting, and planning precise implant placements. Advanced software enhances implant planning by enabling 3-D visualization and simulation, facilitating accurate surgical guides, and reducing complications. Post-surgery, CBCT scans monitor implant success and bone health, aiding in assessing integration and detecting complications promptly. CBCT systems may cause variability and inconsistency in density estimates due to image noise and scanner detection system issues. Unlike medical CT scanners, CBCT provides grey scale values (Image Brightness level) rather than actual X-ray absorption measurement values in HU compared to CT scanners (Hounsfield units or HU, measurement used in computed tomography (CT) scanning to quantify the radiodensity of tissues). But, CBCT scans can identify pathological conditions such as inflammation or retained roots in proposed implant sites and evaluate the status of prior grafting procedures like sinus grafts and alveolar ridge grafts, among others. Compared to traditional panoramic radiographs, CBCT offers superior accuracy in assessing bone graft quality and quantity while exposing patients to similar radiation levels. Additionally, in cases of complications, CBCT scans enable precise evaluation of graft proximity to vital structures or the consolidation of graft material (Angelopoulos & Aghaloo, 2011)

Advanced Computer-Assisted Planning for Dental Implants with CBCT technique

Third-party applications dominate computer-assisted planning for dental implants, utilizing CBCT data in DICOM format. These applications offer sophisticated features like implant simulations, 3D visualization, and anatomical structure marking. By converting CBCT data into proprietary formats, they provide realistic views of the maxillofacial skeleton and soft tissue, along with libraries of CAD/CAM files for implants and prosthetic appliances. These tools enable precise manipulation of implants in a 3D virtual environment, enhancing placement accuracy. Continuous updates in implant libraries enhance accessibility, displaying implants in various views. Tools for parallel orientation ensure precise placement, while virtual bone removal reveals existing teeth for assessing implant orientation (Orentlicher et al., 2012). Radiographic guides aid in selecting proper abutments pre-surgery. Segmentation techniques isolate structures within scanned volumes but are labor-intensive. Additionally, CAD-CAM surgical guides replicate computer-planned procedures, enhancing precision and reducing complications, advancing clinical accuracy in implant procedures (Angelopoulos & Aghaloo, 2011).

AI algorithms in CBCT scans accurately assess alveolar bone quality for implants, identifying bone density variations for optimal placement (Dhopte & Bagde, 2023). Analyzing CBCT images pixel by pixel, AI detects subtle bone density variations (Moufti et al., 2023). AI datasets recognize patterns indicative of bone quality, automating image analysis and detecting bone density loss or lesions (Urban et al., 2023). AI-powered treatment planning systems optimize implant placement based on patient data and anatomical variations, suggesting suitable size, position, and angle (Urban et al., 2023). AI-driven segmentation accurately isolates dental structures within CBCT scans. Segmentation algorithms use advanced image processing techniques, such as convolutional neural networks, to delineate different anatomical structures in CBCT scans (Urban et al., 2023). It helps create virtual surgical guides based on computer-planned procedures, streamlining implant placement while providig real-time feedback during surgery, ensuring precise execution of the treatment plan. AI Virtual surgical guides based on preoperative CBCT scans and treatment plans incorporate detailed anatomical information and implant specifications, allowing surgeons to accurately position implants according to the plan (Dhopte & Bagde, 2023).

IV. Conclusion

CBCT (Cone Beam Computed Tomography) is revolution in the field of dentistry because it is providing high-resolution 3D images with a lower radiation exposure than conventional computer Tomography (CT) scanners. This imaging device's beam configuration with a cone shape and single scanning mode contributes to the scanning efficiency and aids in preimplant evaluation and treatment planning. While it seems a perfect option but there are limitations such as lower contrast and potential radiation risk that needs to be considered. Apart from the high-tech computer-aided planning and AI algorithm, these advancements offer the capability of precisely placing an implant and also improving the patient's outcome. The use of CBCT in dental practice has a wide impact, demonstrating the growing potential for better diagnostic and treatment plans.

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