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Research Paper

# Cone-Beam Computed Tomography: Applications in Dentistry

Medical Science

**KEYWORDS** : CBCT, Dentistry, Oral Lesions

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## ABSTRACT

*This article reviews the various clinical applications of cone-beam computed tomography (CBCT) and evaluated the level of evidence to determine whether the use of CBCT is justified in various fields of dentistry like oral and maxillofacial surgery, endodontics, implantology, orthodontics, temporomandibular joint disorders, periodontics, and restorative and forensic dentistry, orthodontics or not.*

**Introduction**

The emergence of cone-beam computed tomography (CBCT) has expanded the field of oral and maxillofacial radiology. CBCT imaging provides three-dimensional volumetric data construction of dental and associated maxillofacial structures with isotropic resolution and high dimensional accuracy. A CBCT scanner uses a collimated x-ray source that produces a cone- or pyramid-shaped beam of x-radiation, which makes a single full or partial circular revolution around the patient, producing a sequence of discrete planar projection images using a digital detector. These two-dimensional images are reconstructed into a three-dimensional volume that can be viewed in a variety of ways, including cross-sectional images and volume renderings of the oral anatomy.

Although CBCT units produce a higher radiation dose than one would receive from a single traditional dental radiograph, the radiation dose delivered typically is less than that produced during a medical multichannel computed tomographic scan. CBCT radiation doses also vary widely according to the device used, x-ray energy and filtration, tolerance for image noise and motion artifacts, and the size of the imaging area (field of view [FOV]) that is used to acquire volumetric data.[1-5]

**CBCT in Diagnosis of Temporomandibular joint Disoorders**

Panoramic radiography is an acceptable initial tool for the assessment of temporomandibular joint (TMJ) osseous structures. But because of the known limitations of panoramic radiography, the absence of radiographic findings in a symptomatic patient does not rule out obscured osseous

changes; moreover, radiographic findings, if present, may not be revealed in full. Conventional tomography has been used extensively for the evaluation of TMJ hard tissues; however, technique sensitivity and the length of the examinations made it a less attractive diagnostic tool for the dental practitioner. CBCT images not only can be taken in the office but also viewed from many different angles and from an almost infinite number of slices. CBCT images of the TMJ have been shown to provide greater reliability and accuracy than tomographic or panoramic views in detecting condylar erosions.

**CBCTin Oral and Maxillofacial Surgery**

CBCT imaging has great role in evaluation of impacted canine. In the past, SLOB technique was used to compare two periapical radiographs taken at different beam angles to determine the facial/lingual position of the impacted canine; however, the degree of displacement is difficult to determine. CBCT imaging is precise in determining not only the labial/lingual relationship but also a more exact angulation of the impacted canine[5,6]. These 3D images are beneficial in determining the proximity of adjacent incisor and premolar roots, which can be invaluable in determining the ease of uncovering and bonding and the vector of force that should be used to move the tooth into the arch with a lesser chance of adjacent root resorption. To view root fractures radiographically CBCT scans can be acquired quickly and the teeth of interest may be viewed from various angles and directions[7]. The ability to view the cut of a single tooth of interest in the three planes of space makes determining if the involved tooth displays fracture much easier.

**CBCT in Periodontics**

2D intraoral radiography is the most common imaging modality used for agnosing bone morphology, such as periodontal bone defects. However, the limitations of 2D radiography could cause dentists to underestimate the amount of bone loss or available bone due to projection errors and has led to errors in identifying reliable anatomical reference points.118 These findings confirm the observation by Misch et al that 2D radiographs are inadequate for detecting changes in bone level or determining the architecture of osseous defects.119 CBCT provides accurate measurement of intrabony defects and allows clincians to assess dehiscence, fenestration defects, and periodontal cysts. While CBCT and 2D radiographs are comparable in terms of revealing interproximal defects, only 3D imaging such as CBCT can visualize buccal and lingual defects. CBCT has been used to obtain detailed morphologic descriptions of bone as accurately as direct measurement with a periodontal probe. CBCT can also be used to assess furcation involvement of periodontal defects and allow clinicians to evaluate postsurgical results of regenerative.[8-14]

**CBCT in Endodontics(NJ)**

The technology has not yet been perfected for accurate caries detection using the cone beam scanner. CBCT imaging for caries should be limited to non restored teeth. Still we do not know the effect of beam hardening on producing possible artifacts and false-positives. Apparently, sensitivity may increase with CBCT but it should not be at the cost of specificity. The three-dimensional scanning of all the roots of a tooth during endodontic treatment to detect perforation or aberrant canals is useful. This application alone can prevent the loss of countless numbers of teeth each year. CBCT for endodontic purposes appears to be the most promising use of CBCT, in many instances instead of 2D images. Applications would include apical lesions, root fractures, canal identification, and characterization of internal and external root resorption.[15-17]

**CBCT in Orthodontics:**

The causal relationship between airway disorders and malocclusion leads to the classic appearance of adenoid facies. Perhaps

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as a result of the lack of diagnostic instruments in this area, the focus on patient airway assessment seems to have subsided until CBCT arrived and aided in the evaluation of airways.In the past, soft tissue evaluation was difficult using 2D photographs and radiographs. The patient's profile has been the most common soft tissue projection evaluated using photographs and lateral cephalometric radiographs. The profile is visualized using photographs; however, tracings and landmark analysis of the profile are quantified using the soft tissue observed on the lateral cephalometric radiograph[11]. Using the soft tissue data gathered in the CBCT scan, it is possible to rotate and tilt the head in an infinite number of positions to evaluate symmetry of the soft tissue. The positioning of the nose, the alar base fullness, and the inferior border of the mandible are only a few of the items easily studied.[16-19]Several applications of CBCT in orthognathic surgery treatment simulation, guidance and outcome assessment have been developed. CBCT 3D surface reconstructions of the jawbones are used for preoperative surgical planning and simulation in patients with traumas and skeletal malformations. Coupled with dedicated software tools, simulations of virtual re-positioning of the jaws, osteotomies, distraction osteogenesis and other interventions can now be successfully implemented. Pre and post-operative 3D CBCT skull models can also be registered (i.e. superimposed on each other) to assess the amount and position of alterations in the mandibular rami and condylar head following orthognathic surgery of the maxilla and the mandible[21].

### CBCT in Implant Dentistry

The increasing need for dental implants to replace missing teeth requires a technique capable of obtaining highly accurate alveolar and implant site measurements to assist with treatment planning and avoid damage to adjacent vital structures during surgery. In the past, such measurements generally were obtained by utilizing 2D radiographs and (in specific cases) with the aid of conventional CT. However, CBCT is the preferred option for implant dentistry, providing greater accuracy in measuring compared to 2D imaging, while utilizing lower doses of radiation. New software has reduced the possibility of malpositioned fixtures and damaged anatomical structures. CBCT has reduced implant failures by providing information about bone density, the shape of the alveolus, and the height and width of the proposed implant site for each patient.CBCT does not provide accurate Hounsfield unit (HU) numbers; as a result, bone density numbers measured with this technique.[22-26]

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