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Review Article

Role of Cone Beam Computed Tomography in Various Fields of Oral and Maxillofacial Region- A review

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ABSTRACT:
Cone Beam Computed Tomography (CBCT) is a most valuable imaging technique used in oral and maxillofacial surgery. The introduction of CBCT for imaging the oral and maxillofacial region, holds a major change from two dimensional to three-dimensional approach. CBCT provides a complete 3D view of the oral and maxillofacial structures with high resolution which helps for accurate diagnosis, treatment planning andpostoperative outcomes compared to conventional 2D images. Radiation exposure to the patient is very low in CBCT. The main clinical applications of CBCT arein oral and maxillofacial surgery, orthodontics, periodontics and in endodontics. The aim of this article is to review on the advantages, disadvantages and clinical applications of CBCT in the oral and maxillofacial surgery.
Keywords: CBCT, Oral and Maxillofacial, periodontics, paediatric dentistry.

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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.[1]

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.[2-6]

APPLICATION OF CBCT IN VARIOUS FIELDS OF DENTISTRY

CBCT IN PAEDIATRIC DENTISTRY[7-17]

1. Caries
2. CBCT images display better detection of proximal carious lesions as compared to conventional digital intraoral techniques. However CBCT has its own limitations as it is unable to detect carious lesions in metal restored crowns and tooth with radiopaque restorations.3.2. Diagnosis of supernumerary teeth

   CBCT evaluation of impacted supernumerary teeth is recommended to reduce the risk of damage to the surrounding anatomical structures as they are in close association with cortical bone.
3. **Endodontic applications:** CBCT is a promising diagnostic tool foe complex endodontic cases. It is not always feasible to analyze the extent of periapical pathologies, perforations, obturations, root fractures, location of fractured root canal instruments in root canals with traditional radiographic techniques. CBCT is an efficient diagnostic tool to give an enhanced view of

calcified canals and missed canals, and to measure root length and angle of curvature.5

4. **Dental trauma:** It has been found that CBCT can lead to very high diagnostic accuracies for root fractures of non-endodontically treated teeth as compared to conventional periapical radiographs.
5. **TMJ disorders:** CBCT is a cost-effective and dose-effective alternative to CT for TMJ examination. It is more advanced in assessment of osseous TMJ abnormalities as compared to traditional imaging modalities like radiography and MRI.
6. **Patients undergoing orthodontic treatment:** Pediatric patients undergoing orthodontic treatment can benefit from CBCT as it can provide valuable diagnostic information regarding assessment of ankylosed and submerged primary tooth, evaluation of impacted canine and premolar, evaluation of buccal and lingual cortical plates and assessment of proposed sites of temporary anchorage devices. It is also a valuable tool for planning of orthognathic surgeries.
7. **Forensic odontology:** Currently CBCT has been used commonly in forensic odontology for age estimation, forensic facial reconstruction, analysis of bite-marks, sex determination, and frontal sinus pattern.

PRACTICAL APPLICATIONS OF CBCT IN ORTHODONTICS[18-28]

IMPACTED TOOTH POSITION

The most recognized need for CBCT imaging in orthodontics is that of impacted canine evaluation. CBCT imaging is precise in determining not only the labial/lingual relationship but also a more exact angulation of the impacted canine. 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. It also helps in deciding the vector of force.

ROOT RESOPRTION

Routinely Orthopantomograms and intraoral periapical radiographs are used to view root resorption, but these radiograhs have certain limitations due to which they are unable to provide adequate information. Root resorption can be observed readily in CBCT images, and the image clarity allows clinicians to classify the type of root resoprtion. For teeth with multiple roots, resoprtion can be localized to a specific root.

FRACTURED ROOTS

To view root fractures radiographically, it may be difficult if the fracture is in an oblique direction. With CBCT, the tooth of interest can be viewed in all the three planes of space making it easier to determine the site of root fracture and degree of displacement.

ORTHODONTIC IMPLANTS PLACEMENT

The knowledge of the root positioning can greatly enhance the opportunity for proper placement and success of orthodontic implants. CBCT images allow more accurate and dependable views of the inter-radicular relationships than panoramic radiographs. CBCT data can be used to construct placement guides foe positioning mini-implants between the roots of adjacent teeth in anatomically difficult sites. The volume and quality of the bone in the proposed placement sites can be evaluated before insertion of the mini-implants.

LOCATION OF ANATOMIC STRUCTURES

Anatomic structures, such as the mental foramen, inferior alveolar nerve, maxillary sinus, and adjacent roots are easily visible using CBCT. CBCT images also allow precisemeasurement of distance, area and volume which helps the clinicians in treatment planning for sinus lifts, ridge augmentations, extractions and implant placements.

CBCT IN PERIODONTICS[29-36]

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. 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. 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.

CBCT IN ORAL AND MAXILLOFACIAL SURGERY[37-39]

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. 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 resoprtion. To view root fractures radiographically CBCT scans can be acquired quickly and the teeth of interest may be viewed from various angles and directions. 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 IMPLANT DENTISTRY[40-44]

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 aidof 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.

CBCT IN ENDODONTICS[45-47]

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 threedimensionalscanning 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 resoprtion.

CBCT IN ORAL AND MAXILLOFACIAL PATHOLOGY[47-50]

Pathologic lesions including infections, cysts, tumoursand osteonecrosis can be visualized by CBCT. The CBCT aids to visualize the accurate localization of pathology and its association with vital structures inmultiple views. For osteonecrosis of the jaws, CBCT imaging provides a high-resolution 3D analysis. 3D model preparation and adaptation of the reconstruction plates to the jawbone before surgery are possible withCBCT imaging for maxillofacial reconstruction patients. CBCT images are used to visualize growth change, appreciate borders and relative approximation of adjacent vital structures. CBCT is limited in soft tissueanalysis, though it does possess certain clinical applications in the evaluation of malignancies.But benign soft tissue lesions demonstrate poor diagnostic potential with CBCT. Advantages of CBCT are it provides highqualityimage with minimal distortion, decreased cost and lower radiation exposure when compared to MRI and CT. Disadvantages are lack of soft tissue definition. CBCT provides sufficient imaging for mostodontogenic lesions. CT or MRI is indicated if there is evidence of soft tissue involvement.

CBCT IN TEMPOROMANDIBULAR JOINT[47,51]

CBCT imaging are useful in diagnosing degenerative changes, ankylosis, joint remodelling, and malocclusion, congenital and developmental malformations. CBCT are used to supplement other imaging techniques, suchas MRI. CBCT are used to measure condylar volume and surface area, as well as a comparison between the condyles.

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