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## RESEARCH ARTICLE

# DENTAL DIAGNOSIS AND TREATMENT PLANNING WITH CBCT

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**ABSTRACT**

In the dental field, diagnosis and treatment planning is given the utmost importance and for that reason, 3D imaging with cone beam computed tomography (CBCT) was introduced. CBCT enables the three dimensional evaluation of the structures. Therefore, it allows to identify the exact location and extent of dental lesions in a specific anatomic position. The wide ranging applications of CBCT enable it to be utilized in the fields endodontics, orthodontics, periodontics, oral surgery, implantology and other fields. The objective of this review is to provide up-to-date information to dentists regarding the applications of CBCT for different dental specialty to enable an accurate diagnosis and successful treatment.



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# INTRODUCTION

Radiography is observed to be the most commonly used diagnostic tool in clinical dentistry. More than a quarter of the medical-related radiographs are performed by dentists. Radiography in dentistry has been an important resource for diagnostic information since its discovery. The two dimensional imaging techniques are not able to describe the intricate anatomy of the dental structures and the related disorders of head and neck in complete detail. Therefore, three dimensional imaging systems such as cone beam computed tomography (CBCT) presenteda solution to this problem for dental diagnosis and treatment planning (Jacobs, 2011). These developments in 3D imaging are used increasingly for the endodontic diagnosis and treatment planning, oral implant placement, oral surgical planning as well as for orthodontic treatment (Van Assche *et al*., 2010; Van Assche, 2012; Vercruyssen, 2015). The 3D imaging was initially undertaken by the medical computed tomography (CT) but later was replaced by Cone-beam Computed Tomography (CBCT) for a majority of dental applications (Jacobs, 2011; Jacobs, 2000). The chief advantages of CBCT are the ability to perform volumetric imaging with a lower cost than medical CT, less radiation dose than medical CT, and a relatively compact, and affordable equipment compared to medical CT. For patients undergoing implant therapy, 3D imaging can be helpful not only for the diagnosis but also for gathering the integrated patient information for presurgical and treatment-applications for oral implant placement. In addition to the diagnosis potential of 3D imaging, the computer-aided design and computer-aided manufacturing (CAD/CAM) systems have provided new applications for surgical implant planning and delivery of implant-supported prosthesis.

**Applications of CBCT in Endodontics:** CBCT can be useful for diagnosing caries because caries detection and depth evaluation in the occlusal carious lesions and proximal carious lesions is increased with CBCT compared to 2D imaging. But in cases of metallic restorations can lead to artifacts with CBCT and can decrease the diagnostic accuracy of CBCT (Tyndall, 2008). Therefore, CBCT imaging for caries should be restricted to teeth without restorations. The diagnostic-sensitivity would be increased with CBCT but in teeth with restorations the specificity may be reduced (Tyndall, 2008). In the endodontic field, CBCT is also useful for the assessment of the presence of periapical lesion, its extent, and differentiation of the solid-lesions from fluid-lesions such as periapical

granulomas and periapical cysts by utilizing the gray scale values in the lesions (Tyndall, 2008). CBCT is useful in identifying all the root canals in the teeth, specially in teeth with bifurcated root canals. CBCT also helps in identifying a second mesiobuccal canal of maxillary-first molars and identifying the accessory canals (Tyndall, 2008). CBCT therefore plays a vital role in completing the endodontic treatment successfully as it help sin accessing, cleaning, shaping, and obturating of all root canals by enabling the three dimensional evaluation of the root canals (Scarfe, 2009). CBCT is also helpful in identifying the extent of pulpal horns in talons cusps on lateral incisors, aberrant pulpal anatomy on any tooth such as dens invaginatus (Alqerban, 2013). With the help of CBCT, clinicians can differentiate pathology from normal anatomical variation and identify the relation and proximity of anatomical structures. Moreover, with the help of CBCT, traumatic incidents leading to fractures, luxation, displacement, alveolar fracture can be diagnosed and treatment can be rendered accordingly (Cohenca, 2007; Cotton, 2007; John, 2008; Tsurumachi, 2007; Young, 2007; Patil, 2015).

**Applications of CBCT in Orthodontics:** In orthodontics, skeletal maturation is assessed with cervical vertebra maturation index by evaluating the structure and shape of cervical vertebrae. It has been reported that with positional errors, 2D imaging can lead to overestimation of cervical vertebral assessment whereas CBCT can show the cervical vertebrae without any errors due to head positioning.[14] CBCT can be used for evaluating teeth eruption, impactions, especially the maxillary canine position and identifying the precise location of maxillary impacted canines to plan the biomechanics accordingly. Also, CBCT can help in identifying the presence and extent of root resorption for maxillary lateral incisors (Alqerban, 2013). CBCT can also be used for the identification of normal sites for the placement of mini implants such as in the palate (Chhatwani, 2019).

This is especially useful in patients who are undergoing mini implant based appliances such as miniscrew supported rapid palatal expansion and mini plates (Mehta, 2021). With the help of CBCT, the outcomes of orthodontic treatment can be evaluated by comparing the pretreatment to the posttreatment CBCT. Studies have been reported using CBCT on how maxillary expansion can affect airway volume of patients who have undergone miniscrew supported rapid palatal expansion (Mehta, 2021). The number of mini implants used for the MARPE appliance differs according to the purpose of the expander (Nojima, 2018). The mini implants can be placed on one side of the palatal arch or on both sides of palatal arch (Dzingle, 2020). CBCT play an integral role in determining the safe sites for insertion of mini implants and minimize the complications (Bittencourt, 2011). The temporomandibular joint structures can be seen without overlap with CBCT. Because of this, CBCT has also been used to analyze how orthodontic treatment with rapid palatal expansion affects the temporomandibular joint (Mehta, 2021). With the help of CBCT, studies have identified the position of condyle with respect to the mid-sagittal plane and also superior, posterior, and anterior joint space. In addition, CBCT can be used to evaluate clefts, surface imaging, third molars, etc (Dang, 2009).

**Applications of CBCT in Periodontics:** In the periodontic field, CBCT allows to measure the bone loss, and evaluate the presence of craters, furcation involvement, fenestrations, and dehiscence. CBCT is not used routinely to evaluate the periodontal bone support. But high resolution CBCT for a limited field of view may be used in selected cases of infrabony defects and furcation lesions, where clinical emanation and 2D imaging examination do not give the detailed information. CBCT can therefore have a role in the management of complex periodontal pockets or defects in which surgical treatment is performed (Tyndall, 2008; Dang, 2009). Furthermore, CBCT is also used for evaluation of the 1-month postoperative evaluation to assess the bone density and defect regeneration which cannot be evaluated adequately with 2D radiographs (Tyndall, 2008). CBCT is also useful in identification of the size of bone-defects in patients with periodontitis. IT can help in evaluating the periodontal ligament space, measurement of gingival tissue, and dimensions of dentogingival unit (Mohan, 2011). This technique, known as ST-CBCT, is useful in visualizing and measuring the distances of the hard tissues and soft tissues of periodontal ligament and the surrounding sutrcutures (Mohan, 2011; Afrashtehfar, 2012; Afrashtehfar, 2013).

**Ther Applications**

CBCT is also useful for surgical treatment planning and 3D simulations of surgical treatment. It is also used extensively for implant planning and placement. With the help of 3D printing, Surgical guides can also be printed based on the CBCT image for the placement of implant. Such procedure can prevent complications and increase the success rates with implants. For implantology, CBCT can be used to plan the exact implant position, plan sinus lift procedures, plan intra-alveolar distraction osteogenesis, identify the bone height and width as well as identify the course of the nerve to avoid placing the implant in close proximity to the vital structures. CBCT is also used in forensic dentistry for the age assessment for any individual including those who have passed away (Bérgamo, 2016; Nodehi, 2015).

**Limitations of CBCT:** Even though CBCT is useful for a variety of applications, there are certain limitations with this 3D imaging modality. The limitations are the cone beam projection geometry, contrast resolution and the inability to record the soft tissue contrast very accurately.[29] Another disadvantage of CBCT is the image artifacts, which occur as streaking, shading, or distortion due to motion artifacts, metal artifacts or other reasons.[30] CBCT also requires high initial investment in the area to be installed and appropriate lead barriers to be placed around the machine.[30]

# CONCLUSION

CBCT is a very useful tool for dentists for performing diagnosis and treatment planning as it allows a three dimensional view of the dental and related structures. IT can help with evolution of airway constriction and obstructions as well for assessment of age of the patient. For endodontist, it is useful in that it can help in evaluating cares, anatomy of root canals, obturation, and root fractures. For orthodontists, it is useful is evaluating the skeletal maturation of patient, temporomandibular joint, and effect of different treatment procedures. For periodontists, it enables the assessment of alveolar bone, periodontal ligament, and surrounding studies. CBCT also has multiple applications for implantology and oral surgical applications.

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