

CBCT: Third eye in dentistry

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Abstract

Cone beam computed tomography (CBCT) has been one of the most revolutionary innovations in the field of dentistry. Comprehensive visualization and records of the craniofacial complex have been goals in dentistry. These approaches have evolved dentofacial imaging. These tasks have been performed by means of plaster, digital photographs across time, and cone-beam computed tomography (CBCT) has emerged as a comprehensive imaging technology for dentistry. Two dimensional radiographs are insufficient, especially in complex cases like impacted teeth, supernumerary teeth and surgeries. CBCT images provide better detailed information than conventional 2D radiographs and are user friendly. Soft tissues, skull, airway and the dentition can be observed and measured on CBCT images in a 1:1 ratio. This article focuses on numerous applications of cone beam volumetric technology in dentistry.

Keywords: CBCT, 3D imaging technology, Diagnosis, Dentistry, Implant.

Introduction

A correct diagnosis needs to be based on accurate images and measurements of the craniofacial region and is crucial for the development of a valid treatment plan. Earlier before the discovery of X-rays, direct craniometric and anthropometric measurements were used.¹ At the beginning of the 20th century, plaster was the primary material used to capture dentofacial morphology.^{4,6} On Friday, 8th of November 1895 when Sir Wilhelm Conrad Roentgen accidentally invented the X-rays, unfold the hidden secrets and mysteries and gave the world the best tool to diagnose.¹³

Technical advances in dentistry are occurring at an exponential rate. Dental radiology has undergone radical technological shifts in the last 30 years. During that period, we have gone from the dip tank to automatic processing to digital radiography.¹⁴ We have now arrived at the 3D revolution in dentistry. 3D craniofacial imaging techniques have changed the dentistry approach towards diagnosis and treatment planning.¹⁷ Recently, a new technology is catching the attention of the dentistry- cone beam computed tomography (CBCT).¹ Thus there has been a paradigm shift in the approach to diagnosis, with conventional radiography taking a back seat.¹⁰

CBCT is an evolution of the original computed tomography (CT) proposed by Hounsfield and Comark.¹ Although computed tomography (CT) is still used in many clinical situations, its use has become limited in dentistry due to its high cost, low vertical resolution and high dose of radiation.^{7,18} CBCT scanner is intrinsically 3D in its acquisition of images and provides usable images from equipment that is compact and affordable for small diagnostic centres. CBCT is referred to as the “gold standard” and even the “standard of care” for diagnostic maxillofacial imaging.²¹ The radiation dose to the patient with CBCT

is 40-84% lower than that of multislice CT but is 3-7 times more than conventional panoramic radiography.²²

In dentistry CBCT has been used in assessment of caries, periodontal problems, assessment of periapical diseases, trauma, impacted third molars, assessment of temporomandibular joint, diagnosis and treatment planning.²⁴ All these applications, and many others, benefit from viewing thin slices through the region of interest without superposition of local complex onto the image, will become the standard of quality in near future.¹⁹

The purpose of this article is to have centre of interest on emerging role of CBCT in Dentistry.

Application of CBCT in Dentistry: Cone beam computed tomography (CBCT) has revolutionized the imaging of the maxillofacial region in fields of dentistry including endodontics, oral and maxillofacial surgery, prosthodontics, periodontics, orthodontics, pedodontics and Forensic dentistry. It should not be considered as replacement of 2-dimensional projection radiographic applications but rather as a complimentary modality for specific applications.^{15,16,20}

Implantology: The application of CBCT has left excellent impact in the implant area more than any other in dentistry. It provides cross-sectional images in various planes of the alveolar bone height, width and angulation and accurately locates the vital structures such as inferior alveolar canal in mandible and maxillary sinus. The science CBCT in dental implantation has added safety and accuracy and has reduced the need for supportive procedures like bone and tissue grafts in numerous situations. Radiographic stents can be inserted at the time of scan to which serves as a precise reference of the location of proposed implants.

The use of computer-guided implant surgery has tremendously enhanced the dental implant team's ability to plan, place, and restore implants accurately, with a level of precision that was unattainable a few years ago. It offers the patient an advanced level of care with reduced treatment time and a predictable final result.^{8,15,19}

Endodontics: The technology has not reached perfection for accurate caries detection using the cone beam scanner. CBCT imaging for caries should be limited to non-restored teeth. But 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.²³ 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 anatomy identification, and characterization of internal and external root resorption.

Periodontics: The time-honored method for monitoring periodontal bone loss has been through the use of a periodontal probe and bitewing radiographs. Although this method is inexpensive, it is technique-sensitive and does not allow full visualization of the area. In addition to added visualization with CBCT images, most software includes tools for evaluating and monitoring bone density, which may help assess the effectiveness of treatment, predict the results of treatment, or identify areas of future concern. As for periodontal disease, CBCT promises to be 3D imaging for the visualization of bone topography and lesion architecture.

Orthodontics: The justification for using CBCT in orthodontics is linked intricately to its diagnostic and therapeutic efficacies, for which research supporting its use has been performed in a relatively small subset of clinical problems that include impacted teeth, cleft lip and palate and orthognathic surgery.

CBCT likely will provide information that could result in boon in one or more of the following outcomes: (1) enhanced diagnosis, such as precisely localizing impacted and supernumerary teeth; (2) measuring the magnitude of a defect or deformity, such as in patients with craniofacial anomalies; (3) improving differential diagnosis of skeletal, dental or combined malocclusions (4) helping to identify possible causes of malocclusions, such as the contribution of TMJ abnormalities to an open bite or asymmetry;¹⁰ (5) planning for placement of Temporary anchorage devices.

Oral and Maxillofacial Surgery: In the areas of oral surgery and oral pathology, the data from the CBCT can have a profound impact on decision making. The location and root configuration of impacted and unerupted teeth can be seen with exceptional clarity. The proximity to adjacent structures can be seen and recorded with digital accuracy. The extension of periapical lesions, areas of bone destruction, and involvement of the maxillary sinus are all clearly

defined. Even those "spots" seen on traditional radiography can be pinpointed and diagnosed, eliminating the question of artifact and allowing the dentist to give patients definitive diagnosis.^{5,12}

Forensic Dentistry: Many dental age estimation methods, which are a key element in forensic science, are described in the literature. CBCT has been established as a non-invasive method to estimate the age of a person.

Conclusion

It is an exciting time in dentistry, where we can reach beyond the limitations of our senses to see what's really happening in the mouth and associated hard structures with the help of the most advanced technology the cone beam computed tomography.

Based on research evidence, dentist are advised to use their best clinical judgement when prescribing radiographs, including CBCT scans, to obtain the most relevant data using the least ionizing radiation possible.¹¹

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