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Review Article

Cone Beam Computerized Tomography - A Boon to Dentistry

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ABSTRACT

Apt diagnosis is the key to a proper treatment plan and for a good prognosis. Use of additional radiographic diagnostic aids like 2-Dimensional and 3-Dimensional cone-beam computerized tomography (CBCT) help the clinician for imaging and diagnosing areas which are not visible to human eyes. Though history recording and clinical examination form an integral part of the diagnosis use of cone-beam computerized tomography radiographic methods gains popularity among clinicians as it is non-invasive and its ease of application. As Cone-beam computerized tomography is widely used in dental and maxillofacial imaging it is vital that clinicians be updated with the latest innovations and technologies in the field and as the use of CBCT is emerging the field of dentistry one should learn and use it in clinical practice.

Key words: Clinical Education, Cone Beam Computerized Tomography, Dentistry, Oral Diagnosis, Radiology

INTRODUCTION

Cone Beam Computerized Tomography (CBCT) was introduced in 1998 into the field of dentistry which generates 3-Dimension images that help in diagnosis, treatment and follow-up. It offers numerous advantages when compared to traditional 2-Dimensional intraoral radiographs, conventional Computed tomography (CT) and Magnetic Resonance Imaging (MRI). It produces high resolution at low dose radiation rate & less expensive. [1,2]

CBCT is a technique which uses a cone-shaped X-ray beam that is centred on a flat 2-Dimensional (2D) detector which passes through the patient. The X-ray head & the detector revolve around the patient head and sequences of 2-Dimensional images are generated. These 2D images are then reassembled and converted into a 3-Dimensional (3D) image using an algorithm made by Feldkamp in 1995. It works under the principle of multi-planar reformation. [1] There are many advantages of CBCT over conventional radiographic methods like low radiation dose, produces more accurate images, the rapid scan time of about 10 – 70 seconds, low level of metal artefacts and so on. [3]

APPLICATIONS OF CBCT IN DENTISTRY

Oral and Maxillofacial Surgery: Newtom was the first commercially available CBCT system for the oral & maxillofacial region. They are used in the diagnosis of exact location & extent of jaw pathologies, impacted teeth, paranasal sinus pathology & pretreatment evaluation, obstructive sleep apnea, trauma & in orthognathic surgeries. [1]

Endodontics: CBCT identifies the lesion even before their existence becomes identified on conventional radiographs. CBCT detected the periapical lesions 62%

more than the traditional radiographs. It also helps in assessment of root canal anatomy & morphology, diagnosis of root resorption & vertical root fracture. It is also a useful tool in the planning of endodontic surgery by revealing the spatial relationship of specific tooth roots near to vital structures. CBCT with increased resolution as the detection rate enhanced from 60-93%. It accurately assesses the degree of curvature & henceforth, increases the success rate of root canal treatment. [3]

Orthodontics: CBCT has a big role in orthodontics which aids in the assessment of skeletal growth pattern, the severity of tooth impaction & helps in treatment planning.

Implantology: At present CBCT is the most preferred option for implant dentistry for greater accuracy by providing information about bone density, the shape of the alveolus & height & width of the proposed implant site for every patient.

Periodontics: CBCT helps to visualize buccal & lingual defects as it is a 3D imaging system. It is useful to assess the furcation involvement

Forensic Dentistry: Age Estimation is one of the most important aspects of forensic dentistry. CBCT is a non-aggressive alternative to the traditional methods.

TMJ Disorders: CBCT is involved in the diagnosis of TMJ disorders as it reveals both the hard tissue & soft tissue around the joint as much as possible without the appearance of folded images. It is recommended over MRI, as CBCT has lower radiation dose. It is the best imaging tool for TMJ injuries & fibrous ankylosis, pain, dysfunction, cortex erosion of cortical condyle & cyst.

Other Applications: Supplementary findings detected in CBCT images apart from the primary goal of this scans has been reported to be as high as 25%. It may also involve the imaging of airway, nasal polyps, cervical vertebra clefts & endodontic lesions.

DISCUSSION

As for now, CBCT is an emerging 3D imaging technology that is used specifically in the maxillofacial region. It has many clinical oriented articles to its name. It is most useful in the field of maxillofacial surgery, implant dentistry, endodontics, orthodontics & little benefit in forensic dentistry. Its role in other fields has to be still established. At present, it is the most successful 3D imaging technique used in dentistry with accuracy and low radiation dose.

REVIEW OF LITERATURE

Adibi S et al (2017) [4] investigated on the influence of the orientations of the skull during the scanning procedure on the accuracy of CBCT images in determining the positional relationship of the mandibular tooth apices to the alveolar canal which resulted in the conclusion that alteration of patient head position during CBCT scanning does not affect the relative position of the Inferior alveolar nerve and apices of the posterior teeth. Barghan S et al (2012) [5] conducted a study to evaluate the cortical and trabecular architecture of the bony structures and confirmed their integrity, to assess the extent and monitor the progression of osseous changes and to evaluate the response of Temporomandibular Joint Disorders. The study showed the CBCT provides high resolution of multiplanar images and delivers substantially lower radiation dose compared with multislice CT. CBCT allows examination of Temporomandibular Joint anatomy without superimposition and distortion to facilitate analysis of bone morphology, joint space and dynamic function in all three dimensions.

Biuki N et al (2017) [6] conducted a study to evaluate the correlation between chronological age and pulp to tooth volume ratios in anterior teeth with the use of CBCT technique and to determine a regression model to estimate human age and the authors advised to use the mean of all the ratios of anterior teeth in forensics to

estimate the age. Buchanan A et al (2016) [7] conducted a study to evaluate the upper airway dimensions of Obstructive Sleep Apnoea and control subjects using a CBCT unit. They concluded that Obstructive Sleep Apnoea have a smaller upper airway compared to the controls with the exception of airway length.

Cantarella D et al (2017) [8] conducted a study to evaluate the Maxillary Skeletal Expander on the mid-palatal pterygopalatine sutures in the late adolescents, using high-resolution CBCT. The study concluded that mid-palatal suture was successfully split by Maxillary Skeletal Expander in late adolescence, and the opening was almost perfectly parallel in a sagittal direction. The pterygopalatine suture was split in its lower region by Maxillary Skeletal Expander, as the pyramidal process was pulled out from the pterygoid process. Choi IGG et al (2017) [9] implemented a new methodology to assess the reliability of CBCT images of the frontal sinus cavity for determining sex based on sexual dimorphism found in this anatomical structure. The methodology demonstrated the existence of sexual dimorphism with an accuracy of 80.0% in the logistic regression model.

Eliášová H and Dostálová T (2017) [10] conducted a study to show the practicality of 3D multislice and Cone-beam Computed Tomography systems for dental identification. The study demonstrated that CBCT imaging offers fewer image artefacts image reconstruction times, the mobility of the unit and considerably lower equipment cost. Enciso R et al (2010) [11] conducted a study to compare the CBCT scan measurements between patients with Obstructive Sleep Apnoea (OSA) and snorers to develop a prediction model for OSA based on CBCT imaging and Berlin questionnaire. The results of the study indicated that 3-dimensional CBCT airway analysis could be used as a tool to assess the presence and severity of OSA.

Gumusok M et al (2016) [12] carried out a retrospective study to determine the radiological features of Keratocystic Odontogenic (KCOT) tumours using Cone-beam Computed Tomography (CBCT). The study drew the conclusion that CBCT is useful in radiological imaging method to examine the radiological characteristics of KCOTs such as bone destruction and their spatial relations with the neighbouring anatomic structures. Kruse C et al (2015) [13] conducted a study to evaluate the diagnostic efficacy of CBCT for periapical lesions and concluded that although there is a tendency for a higher accuracy of periapical lesion detection using CBCT compared to 2-dimensional imaging methods. Leite GMF et al (2014) [14] conducted a cross-sectional study to evaluate the frequencies of anatomical radiations and lesions affecting the mandibular canal in CBCT images of the mandible produced for dental implant planning and drew conclusion that anatomic variation and lesions affecting the mandibular canal were common findings in CBCT images of the mandible produced for dental implant planning.

Mandelaris GA et al (2017) [15] published a systematic review which evaluated whether cone-beam computed tomography (CBCT) imaging can be used to assess dentoalveolar anatomy critical to the periodontist when determining a risk assessment for patients undergoing orthodontic therapy using fixed or removable appliances. The authors suggested that CBCT imaging can include the periodontal diagnostic acumen regarding alveolar bone alterations influenced by orthodontic tooth movement and can help determine risk assessment prior to such intervention. Ozcan G et al (2016) [16] carried out a study to investigate the number and morphology of the root canals of the primary molars, to study the applicability of Cone–Beam Computed Tomography (CBCT) in assessing the same. The study provided comprehensive information to the existing literature concerning the variation in root canal morphology of the maxillary and mandibular primary molar teeth.

Ramos Brito AC et al (2017) [17] conducted a study to compare the detection of fractured instruments in root canals with and without filling by periapical radiographs from 3 digital systems and Cone–Beam Computed Tomographic images with different resolutions. This study suggested that this technique should be the first choice as well as the direct digital radiographic systems. Ratanajirasut R et al (2017) [18] conducted a study that investigated the roots and root morphology of maxillary 1st and 2nd permanent molars in a Thai population using Cone-beam Computed Tomographic Imaging. This study revealed that CBCT imaging is useful in determining root canal morphology. Reis AG et al (2013) [19] conducted a study that aimed to investigate the presence of 2nd mesiobuccal canals in different thirds of the mesio-buccal root of 1st and 2nd maxillary molars using CBCT scanning and to correlate findings with patients' sex and age the study suggested that CBCT scanning is effective in mapping 2nd mesio-buccal canals present in different 3rds of the root.

Sang YH et al (2016) [20] conducted a study with the goal to assess the linear, volumetric, and geometric accuracy of 3D reconstruction from CBCT. The study concluded that 3D reconstruction from CBCT data can achieve a high linear volumetric and geometric accuracy. Silva EJ et al (2014) [21] carried out a study to analyze and characterize root canal morphology of maxillary molars of the Brazilian population using Cone-beam Computed Tomographic Imaging. The study showed that root canal configuration of the maxillary 2nd molars was more variable than the first molars in the Brazilian population. CBCT imaging is a clinically useful tool for Endodontic diagnostic and treatment planning. Zhang R et al 2011 [22] carried out an investigation on variations in root canal configuration in the maxillary permanent molar teeth of Chinese subpopulation using Cone-Beam Computed Tomography (CBCT). The results suggested that CBCT can enhance detection and mapping of the mesio-buccal root canal system with the potential to improve the quality of root canal treatment.

CONCLUSION

Thus it can be concluded that Cone Beam Computerized Tomography (CBCT) is the most efficient Three-Dimensional Imaging System available in dentistry. CBCT examination should not be carried out until it is proven medically and benefits outweigh the risks.

Declaration: Author declares there is no potential conflict of interest

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