**ROLE OF CONE BEAM COMPUTED TOMOGRAPHY IN ORTHODONTICS**

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**ABSTRACT**

Cone beam computed tomography (CBCT) has probably been one of the most revolutionary innovations in the field of Dentistry [1]. CBCT was embraced into the dental settings very rapidly due to its compact size, low cost, and low ionizing radiation exposure to the patient when compared to computed tomography. It is the technology used to take three-dimensional (3-D) images of your teeth, maxillary sinus, nerve pathway, and bones in the maxillofacial region with a single scan. Three-dimensional imaging (3D) evolved to meet the demands of advanced technologies in order to deliver the best treatment and at the same time evolution of new treatment strategies.

**Clinical significance:** CBCT played an important role alongside clinical evaluation in the planning and follow-up of dental implant treatment. It provides an excellent tool for accurate diagnosis, more predictable treatment planning, more efficient patient management, and education, improved treatment outcomes, and patient satisfaction. [1]

**Keywords:**Cone beam computed tomography, 3-D imaging, and maxillofacial imaging.

 **I.INTRODUCTION**

Conventional film-based tomography, also called body-section radiography, is a radiographic technique designed to image more clearly lying within a plane of interest. Today we have the radiography techniques to image and visualize the entire head in 3D view. Cone beam computed tomography (CBCT) has made a remarkable entry into the field of Orthodontic diagnosis in the last few years[3]. CBCT is an imaging technique consisting of X-rays where the X-rays are divergent, forming a cone. With rapid 180° or more (most frequently 360°), a CBCT provides essentially immediate and accurate two-dimensional 2-D and three-dimensional 3-D radiographic images of an anatomical structure. The aim of this article is to elaborate on the application of Cone beam computed tomography in orthodontics through its different and unique image display of the maxillofacial region. [3]

 **II.CONE BEAM COMPUTED TOMOGRAPHY(CBCT)**

**A. What is Cone beam?**

Cone beam imaging is fast, simple, and completely painless 3D x-ray – patients just sit in a chair for asingle10 second scan, and from that scan, the specialist can quickly see computer-generated views of the bones of the face, the teeth, and other details from any angle, in 3-D and in color. CBCT is used to investigate the accurate location of several jaw pathologies such as tumors, inflammatory lesions, and the location of impacted teeth before. It is also used in endodontics, implant dentistry, orthodontics, periodontics, temporomandibular joint imaging, and forensic dentistry. [7]

**B. CBCT vs CT?**

CT imaging is also known as computerized axial tomography (CAT) imaging. It was invented by Godfrey Hounsfield in England at the end of the 1960s and by Allan Cormack in the USA who developed image reconstruction mathematics to provide a cross-sectional of the head. The term tomography comes from the Greek words Tomos, which means to slice or to divide, and graph in, which means to write. So, by definition, it is imaging an object by analyzing its slices. Cone-beam refers to the cone shape of the X-ray beam, unlike conventional CT, which uses a fan-shaped beam to create multiple thin slices [1]. CBCT in dentistry is high resolution and low distortion, digital imaging of the hard tissues of the head and neck region. The resolution in CBCT is measured in voxels instead of pixels and is often sharper than a conventional CT.

**C. HOW DOES IT WORKS?**

CBCT uses a “Cone shaped” divergent beam of ionizing radiation like X-rays and a 2D area detector mounted on a rotating gantry to acquire multiplanar sequential projection images in one scan around the area of interest and the scanning software in the system collects this projection data and reconstructs the image, and producing volumetric data.

**D.CBCT IMAGE RECONSTRUCTION**

During a CBCT scan, many single 2D snapshot images are captured from predefining angles as the machine moves through a single isocentric rotation of the x-ray source/sensor unit. These raw images are then compiled into a 3D dataset with the use of reconstruction algorithms. The volume is often referred to as the “3-dimensional image”

 **III.APPLICTION OF CBCT IN ORTHODONTICS**

* Impacted teeth & ectopic teeth
* Root abnormalities
* Supernumerary teeth
* Pathologies of Jaw
* Dental Development and eruption sequence
* Cleft lip & cleft palate
* Alveolar Bone width
* Dental Anomalies/malformed Teeth

Impacted Teeth & Ectopic teeth:

An impacted tooth is the disturbance of eruption determined by some physical barrier in their path or local factors (lack of space, cysts or benign tumors, odontomas, persistent primary teeth) The diagnosis of impaction or an ectopic position of maxillary canines is usually made by the orthodontist after the clinical and radiographic examination. Impacted maxillary canine has a close association with other tooth and eruption disturbances [9]. A most common indication for CBCT imaging in orthodontics. CBCT has improved diagnosis and contributed to modifications in treatment planning in a significant number of subjects.

Root Abnormalities:

Detection of buccal or lingual root resorption by CBCT that is not visualized by 2-D radiographs could differentiate pre- or in-treatment decisions made with two imaging modalities. So the dilemma, in this scenario is how and when a clinician would decide that a patient has undergone buccal and/or lingual root resorption to justify taking a CBCT scan. Root resorption can be observed readily in CBCT images, and the image clarity allows clinicians to classify the type of root resorption. [1]

Supernumerary teeth:

Supernumerary teeth are any teeth or tooth substance in excess of the usual configuration of twenty deciduous and thirty-two permanent teeth. Supernumerary teeth may, therefore, vary from a simple odontoma, through a conical or tuberculate tooth, to a supplemental tooth that closely resembles a normal tooth [5]. Supernumerary teeth may cause the delayed or impaired eruption of succedaneous teeth, displacement or rotation of permanent teeth, crowding, an abnormal diastema, or premature space closure. CBCT imaging in supernumerary teeth provides an excellent tool for accurate diagnosis and more predictable treatment planning.

Pathologies of Jaw:

Jaw tumors and cysts are growths or lesions that develop in the bone of the maxilla or mandible or the soft tissues in the mouth and face. These growths are usually noncancerous (benign), but they can be aggressive and expand, displace or destroy the teeth, surrounding bone, and tissue. These growths appear to have no causative factors but can prevent tooth movement. Such lesions can be viewed easily using CBCT.[6]

Cleft lip and Cleft Palate:

Cleft of the lip and palate are common congenital anomalies to affect the orofacial region. CBCT can provide the cleft’s accurate anatomic relationships of cleft lip and cleft palate and also bone thickness around the existing teeth in proximity to the cleft or clefts. This can help clinicians in grafting procedure planning and treatments of existing dentition [1]

Dental Development and eruption sequence:

Estimation of the eruption schedule is an important tool in planning diagnostic, preventive, and therapeutic measures. It is also a key indicator when diagnosing certain growth disturbances. A cone beam CT examination to determine the structure and location of retained teeth and the stage of inclusion of the tooth. Eruption disorders are often associated with other dental abnormalities and therefore such cases of eruption disorders of permanent teeth or the inclusion of deciduous teeth increase the likelihood of a correct diagnosis. [10]

Alveolar Bone width:

A high-resolution cone-beam computed tomography (CBCT) system is used to assess apical bone thickness in buccal and palatal/lingual aspects of maxillary and mandibular teeth. [4]

Dental Anomalies/malformed Teeth:

Dental anomalies are caused by complex interactions between genetic and environmental factors during the process of development of the orofacial region. This process is multifactorial, multilevel, and multidimensional. The associations between dental anomalies have been a focus of a number of clinical orthodontists. Early diagnosis allows optimal patient management and treatment planning and can reduce complications and the amount and complexity of the planned treatment.CBCT images allow clinicians to assess Changes in the pattern of tooth eruption which can affect the dental arches contributing to a malocclusion.[8]

 **IV. Conclusion:**

CBCT is a boon in the field of Dentistry. CBCT technique hugely expands the field for diagnosis and treatment possibilities, not to forget many more research frontiers as well. The most common indication for CBCT was malocclusion and dentomaxillofacial anomalies in the primary and permanent dentition age groups, whereas the localization of impacted teeth was the most common indication in the mixed dentition age group. Generally, CBCT was indicated in orthodontics and surgery. However CBCT should be used with careful consideration, it should not be used where 2D imaging suffices.[3]

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