REVIEW ARTICLE

CBCT: The Boon for Orthodontic Diagnosis

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ABSTRACT

This article is a retrospect of the various clinical appositeness of cone-beam computed tomography (CBCT). CBCT was introduced in the 90's, and studies have improved its use in dentistry and their 3D images are able to increase diagnostic accuracy and alter orthodontic treatment plan in a more success approach. CBCT has become an increasingly important source of 3D data in clinical orthodontics. The prospect of this article is to give a brief introduction to CBCT technology and its usage in an orthodontic and clinical setting.

KEYWORDS: Cone beamandComputed tomography, three-dimensional, Orthodontic applications

INTRODUCTION

Two-dimensional (2D) imaging modalities have been used in dentistry since 1896 when the first intraoral radiograph was obtained. Whereas with the introduction of tomography and panoramic imaging which made it possible to isolate areas of interest. More recent advances in digital diagnostic imaging have faster processing and lower radiation doses without affecting the diagnostic quality.[1]

The 2D lateral cephalograms provided limited information during analysis, As Craniofacial structures are three-dimensional (3D) objects.[1,2] That was often obscured in 2D images. The introduction of cone-beam computed tomography (CBCT) and computer software has allowed orthodontists to deal the craniofacial structure with more meticulousness.[2,3]

MOA & NEED OF CBCT

The conventional C.T produces slice-by-slice imaging, where as the CBCT produces a cone-shaped beam that rotates once around the object which is capable of producing hundreds of 2D images of a defined anatomical volume which is not seen in CT.[3,4] The images are then reconstructed in a visualizable 3D data.[4]

CBCT offers numerous advantages in comparison to conventional 2D radiography such as lack of superimposition, the absence of geometric distortions, 1:1 measurements and the most desirable 3D display

Comparisons between CBCT & other Forms of Imaging in Radiation Exposure: CBCT has lower radiation and lower resolution than conventional CT. The currently available CBCT units have variable radiation exposure in the range of 86 to 205 μSv for a full cranio-facial scan. When compared with the radiation exposure of conventional orthodontic images including a panoramic radiograph (14.2–24.3 μSv), a lateral cephalogam (10.4 μS) and a full-mouth series (13–100 μS), which clamis that CBCT radiation exposure is equivalent to or slightly higher than conventional imaging

ACCURACY OF CBCT

CBCT with computer software allows proper representation in three different planes of view: coronal, sagittal, and transverse without distortion of craniofacial structures and provides sophisticated information and has been enhanced with magnification, visual adjustments and cursor-driven measurements.

CBCT imaging is useful in assessing the growth and development of craniofacial anomalies and their abnormalities via 3D superimposition. It is also useful in assessment of condylar cortical erosion to assess TMJ disorder.[5,6]

ADVANTAGES OF CBCT OVER CONVENTIONAL CT[4]

- It involves a smaller system and is less expensive.
- Accurate 3D images are obtained.
- The scan time is rapid and X-ray beam is limited..
- When compared to conventional CT a lower radiation dose is seen but it is high when compared to lateral cephalogram & OPG.

ORTHODONTIC APPLICATIONS OF CBCT

Application in orthodontic diagnosis and Assessment

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of skeletal and dental structures: Conventional cephalometric radiography is limited by the expression of 3D structures onto a 2D plane in its application which interferes with landmark identification and can lead to magnification and distortion of the image obtained.

Landmark identification is also greatly enhanced in CBCT images with magnification and adjustments in contrast. Multiplanar views are especially advantageous in identifying bilateral anatomical landmarks such as condylion, orbitale, and gonion, which are frequently superimposed in conventional radiographs.[4]

3D evaluation of impacted teeth: CBCT provides enhanced precision in the localization of teeth in the arch. Small volume CBCT is also justified as a supplement to routine panoramic X-rays in the following cases: when canine inclination in the panoramic X-ray exceeds 30, when root resorption of adjacent teeth is suspected when the canine apex is not clearly discernible in the panoramic X-ray, implying dilacerations of the canine root .

When comparing conventional radiography with CBCT, it provides more information regarding the location of pathology, the presence of root resorption. However, the benefits of CBCT imaging must be weighed against the radiation risk to pediatric patients, and the complexity of the pathology involved.[4]

Growth assessment can be used to reliably assess cervical vertebrae maturity, which provides a consistent evaluation of skeletal maturity by CBCT scans.

Pharyngeal airway analysis- In comparison, axial cuts of 3D CBCT scans provide soft tissue points that are derived from the projection of shaded areas, which are more clearly visible in axial CBCT cuts compared with conventional radiographs, thereby enhancing airway assessment. Complex anomalies such as enlarged adenoids and obstructive sleep apnea can be best assessed by three-dimensional CBCT-assisted airway analysis which facilitates the diagnosis and treatment planning. [4]

Three dimensions Assessment of the temporomandibular joint (TMJ): For a complete bilateral TMJ exam, four tomographic cuts in both the lateral and frontal planes are needed for each TMJ. In comparison to the conventinal, a CBCT examination requires less time and a single 360_ rotation scan around the patient's head, and it simplifies positioning of the patient. Though in general, CBCT is not the imaging of choice for TMJ disorders such as myofacial pain dysfunction or internal disk derangements.[4]

Cleft palate and lip assessment with the help of CBCT: Patients with cleft lip and palate are useful for both preoperative and therapeutic evaluations with help of CBCT. The several planes and parasagittal sections through the imaging volume have broad applications in the assessment of cleft palate cases. Three-dimensional reconstructions of images in association with 3D navigation systems allow preoperative evaluations of the cleft palate regarding the volume of the bone defect, the location of the bone defect, the presence of supernumerary teeth, and an appraisal of permanent teeth and alveolar bone morphology .[4]

Orthognathic surgical planning with the help of CBCT: CBCT imaging with appropriate software and virtual patent-specific models facilitate the examination of hard and soft craniofacial structures and their relationships. Virtual anatomical models can be formulate from CT volumes and co-registered with other available 3D image data. Thus, the virtual models that are generated can be used to recreate or check treatment options, to create anatomically correct substitute grafts, and can be a critical aid during the surgical procedure. In addition, databases may be interfaced with the anatomical models to provide characteristics of the displayed tissues to reproduce tissue reactions to development, treatment, and function. For example, maxillofacial soft tissues can be attributed with viscoelastic properties and can be correlated with allied hard tissues so that replicated manipulation of the hard tissues (e.g., teeth and skeleton) produces a correct deformation reaction in the attached soft tissues. This method can offer a more distinct image of anticipated changes subsequent to surgical treatment compared with less practical computer modeling.[4]

Placement of temporary anchorage devices(TADs): Three-dimensional scans are especially useful in evaluating the amount and quality of bone available in the desired site of placement of TADs. The TAD stability and success can be assessed with this single diagnostic imaging method, information about surrounding structures, root proximity, and the morphology of maxillary sinuses and the inferior alveolar nerve canal can be obtained, all of which are important in determining the placement of implant. Surgical guides that have been developed using a method employing high-resolution CBCT scans and rapid prototyping have been shown to provide accurate placement of TADs on the buccal aspect of the jaws. Three-dimensional CBCT image have been found to be more accurate than 2D surgical guides in micro implant placement.[4]

Accurate estimation of the space requirement for unerupted/impacted teeth: CBCT scans enable the accurate localization of impacted and/ or transposed teeth, which helps to determine the accurate method for surgical access and attachment placement. Furthermore, CBCT scans provide the orthodontist with valuable information regarding the teeth neighboring the impacted teeth in terms of root proximity which helps in placing adjacent teeth and their roots away from the traction path of the impacted tooth to avoid unwanted changes in these teeth. Another advantage of CBCT over conventional radiographs is its capacity to obtain precise dimensions of an impacted tooth, which aids in estimating and creating the necessary space to accommodate the tooth within the arch.[4]

Fabrication of custom orthodontic appliances: The lingual orthodontic appliances fabrication has been demonstrated using CBCT image data for planning a patient's treatment and the manufacturing of custom

appliances with the help of 3D printing technology. These advances appear to be promising in efficient and effective patient-specific treatments. Correspondingly, Orametrix is a company that has been using CBCT technology for the last several years to provide the data necessary for planning and executing technology- assisted treatment through its SureSmile system.[4]

Investigation of orthodontic-associated sensory disturbances: Secondary to regular orthodontic treatment sensory disturbances are extremely rare. However, when they do occur, they can only be diagnosed by CBCT. A report by Chana et al. (2013) demonstrated the importance of CBCT scans as the sole aid in obtaining a definitive diagnosis of clinical condition by orthodontic treatment-induced transient mental nerve paresthesia.[7]

CONCLUSION

CBCT imaging data provides more accurate information for treatment planning and is beneficial to both patients and practitioners when compared with other conventional imaging methods which allows the clinicians to provide better results in diagnosing a particular case as it provides clinicians with good resolution images of high diagnostic quality with relatively short scanning times and low radiation dose.

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