CBCT AND ORTHODONTICS – A CLINICAL BOND

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ABSTRACT:

In the modern era of dentistry, many radiographic tools are available for the dentist for various clinical and research application. CBCT is one of the greatest imaging tool that is used in the field of dentistry for diagnosis, treatment planning and to evaluate the treatment outcome. This article reviews the application of CBCT in orthodontic diagnosis, treatment planning, and appliance fabrication and to evaluate the treatment outcome.

Key words:

Cone beam computed tomography, orthodontics, diagnosis, treatment plan

INTRODUCTION

Proper orthodontic diagnosis, treatment planning and mechanics lead to successful treatment outcome and imaging play a vital role in diagnosis, treatment planning and achieving the depicted goals. CBCT is one of the greatest imaging tool that is used in the field of dentistry since 1998[1] and its application is rapidly increasing in all the branches of dentistry and orthodontics is not an exception. Despite the availability of many tools, CBCT in combination with a compatible customized software change the way of diagnosis, treatment planning[2, 3]. The application of CBCT in orthodontics is steadily increasing and the objective of this article is to update the role of CBCT in orthodontics. The current application of CBCT in orthodontics can be reviewed under five major categories.

I. CBCT in orthodontic diagnosis.
II. CBCT in orthodontic treatment planning.
III. CBCT in orthodontic appliance fabrication.
IV. Evaluation of treatment progress and outcome.

I. Application in Orthodontic diagnosis

A. Evaluation of skeletal relationship

CBCT imaging in combined with advanced computer software allows anatomical structures to be properly represented in all three viewing planes [sagittal, transverse and coronal]. Landmark identification is also greatly enhanced in CBCT images with magnification and adjustments in contrast[4]. The reproducibility of measurements on cephalometric radiographs obtained from CBCT scans was better than the conventional cephalograms. Multiplanar views are especially advantageous in identifying bilateral landmarks such as condylion, orbitale and gonion which are frequently superimposed in conventional radiographs[5].

B. Evaluation of growth status

CBCT can be used to assess the growth status using cervical vertebrae maturity and hand wrist radiograph[6, 7]. Though CBCT is a reliable tool for assessing the skeletal maturity, it is not recommended to use CBCT exclusively for assessing the skeletal maturity.

C. Evaluation of TMJ

CBCT images provide additional information and clarity in the evaluation of abnormalities in TMJ and its surrounding structures in patients with different malocclusion and TMJ disorder[8, 9, 10]. Malocclusions involving CRCO discrepancies [centric occlusion vs centric relation] may involve displacement of condyle in the TMJ fossa that are significant for proper diagnosis[11]. These information are well appreciated in the CBCT images.

D. Evaluation of maxillofacial anomalies

The real-time creation of images in several planes has broad applications in the assessment and classification of maxillofacial anomalies including cleft palate cases[12]. 3D reconstructions of images allow preoperative evaluations of the cleft palate regarding the volume, extent and location of the bone defect, the presence of supernumerary teeth, alveolar bone morphology etc[13].

E. Pharyngeal airway analysis

Airway analysis in critical in patients with retrognathic mandible, patients with large tongue requiring mandibular surgical

setback, individual with large adenoids and in obstructive sleep apnea cases.[14, 15] Axial cuts of CBCT provides volumetric analysis of airway using the soft tissue points that are derived from the projection of shaded areas. CBCT provide superior data than the conventional lateral cephalogram in airway evaluation thereby facilitates the diagnosis and treatment planning of complex anomalies[16].

F. Spatial and morphological evaluation of impacted teeth

Evaluations of impacted canine play a vital in the planning orthodontic treatment. Whether to extract or not depends up many factors[17]. When comparing conventional radiography, CBCT provides precise information about the spatial localization of impacted canines, its angulation/inclination, its proximity with the adjacent structures, root resorption of adjacent teeth, dilacerations of the root, involve of maxillary sinus, pathological conditions related to the teeth and its adjacent structures etc[18, 19, 20, 21].

II. Application in treatment Planning

A. 3D surgical treatment planning

CBCT imaging in combination with appropriate software and 3D printer is used to produce the virtual models of craniofacial structures[22, 23]. These virtual models are used in various craniofacial/maxillofacial surgical and orthognathic treatment planning. They aid in the proper evaluation and placement of bone grafts, helps to plan maxillofacial orthognathic surgeries, simulation of various orthognathic surgical treatment options [mock surgery], pre surgical fabrication of surgical splints, pre surgical adaption of surgical plates[24, 25, 26 27].

B. Space analysis

CBCT provides exact dimension of teeth without magnification. This allows precise analysis of space discrepancy with in the arch[28, 29, 30].

C. For temporary anchorage device [TAD] planning

Many researches has been done using CBCT data to evaluate the quality of bone buccally, palatally and lingually[31, 32, 33]. Bone quality and thickness is very important in the selection of mini implant site which in turn affect the stability and retention of implant. Most of the valuable information like root

proximity, relationship with adjacent structures, maxillary sinus morphology and inferior alveolar canal can be obtained with single diagnostic 3D imaging and these information aid in accurate evaluation and placement of TAD[34, 35, 36]. Three-dimensional CBCT image based 3D printed surgical guides are more accurate than 2D surgical guides in micro implant placement[37].

III. Role of CBCT in appliance fabrication

CBCT in combination with appropriate software help in virtual treatment planning. The advanced 3D printing technology along with CBCT aid in the virtual planning, customization and fabrication of many labial and lingual appliances that are used both in conventional and lingual orthodontic treatment system[38, 39].

IV. Evaluation of treatment progress and outcome

Evaluation of treatment progress and outcome need superimposition of pre and post treatment images. Comparisons of pre and post treatment images are mandatory to evaluate the post treatment magnitude and area of changes in relation to skeletal, dental and soft tissues craniofacial structures[40]. Conventional radiograph provides only 2D images. CBCT 3D imaging provides accurate superimposition of craniofacial structures. CBCT is particularly useful in evaluating the post treatment changes in the mandibular condyle and pharyngeal airway space following functional therapy, skeletal and dentoalveolar changes following orthognathic surgery and rapid palatal expansion[41, 42, 43, 44].

CONCLUSION

Many studies have been done to demonstrate the various application of CBCT in orthodontics. They are used almost in every aspect of orthodontics like diagnosis, orthodontic/surgical treatment planning, appliance fabrication, evaluation of treatment outcome. Although CBCT provides valuable and accurate information than the conventional 2D radiographs, the prescription of CBCT should be limited to those areas where conventional radiographs cannot provide adequate information.

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