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REVIEW ARTICLE

AN EAGLE'S VIEW IN ORTHODONTICS -A REVIEW ON CONE BEAM COMPUTERISED TOMOGRAPHY

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ABSTRACT

CBCT has upscaled the way diagnosis and treatment planning are performed in recent times. It has become an integral part in planning Temporary Anchorage Devices, Orthognathic surgery, Transverse expansion, Impactions etc. The drawbacks of traditional 2D radiology where three-dimensional structures are viewed on a two-dimensional view has been overcome with the current technique with all due respects to ALARA (As Low As Reasonably Applicable) principle. This review article gives a description about the potential applications of CBCT in the field of orthodontics.

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INTRODUCTION

As clinicians, we often have an enigma about our diagnosis and treatment planning as the clinical examination paints a picture only of the evident possibilities. In contrast, the conspicuous abnormality is overlooked because of the fallbacks in the traditional methods of diagnosis. Cone Beam Computerised Tomography (CBCT) is indeed a boon in the field of orthodontics as it has elevated the treatment possibilities to a whole new level. As the famous quote said "Our mind does not know what our eyes cannot see", CBCT has given us an eagle's view of various abnormalities such as impacted teeth, and cleft, as an aid in the placement of Temporary Anchorage Devices, maxillary expansion, root resorption, airway morphology,3D printing, orthognathic and craniofacial surgery so on and so forth. Introduced in 1998 to the field of dentistry, the impact of CBCT was first discussed in a symposium on "Craniofacial imaging in the 21st century" held in Pacific Grove, CA. The varied utilization of CBCT by clinicians for orthodontic purposes exists within the context of research evidence, published case reports, or anecdotal observations on a broad spectrum of cases ranging from impacted teeth to temporomandibular joint (TMJ) morphology. This article provides a review of the literature on 3D craniofacial anatomy and orthodontic treatment outcomes determined by CBCT as well as evidence-based indications for the use of CBCT in clinical orthodontics. [1]

AS AN AID IN ORTHODONTIC DIAGNOSIS, TREATMENT PLANNING, AND OUTCOMES: CBCT will provide information resulting in the following outcomes 1) improved diagnosis 2) quantifying the magnitude of the pathology 3) Differential diagnosis 4) Identification of possible cause of malocclusion.

IMPACTED TEETH: After third molars, maxillary canines are the second most commonly impacted teeth and demand attention from the orthodontist. CBCT helps in the determination of the position of the impacted tooth, its proximity to the adjacent structures, determination of space requirements, follicular size, and pathology, planning of surgical access and bonding, and determination of optimal force application. A recent study suggests that small volume field of view CBCT may be indicated for impacted maxillary canines if the canine inclination on a conventional 2D panoramic radiograph exceeds 30° relative to a perpendicular midline, when adjacent root resorption is suspected, and/or when canine root dilaceration is suspected on conventional panoramic radiographs.[2]Studies also demonstrate that the original treatment plans derived from 2D radiographs are changed for >25% of the impacted teeth when orthodontists viewed these teeth in CBCT images as opposed to the 2D radiographs typically used for this purpose. Thus, the scientific evidence for the utility of CBCT both in refining diagnosis and modifying treatment plans for significant numbers of impacted teeth validates its use for most impacted teeth.[3]A picture depicting impacted canine in Figure 1a and b.

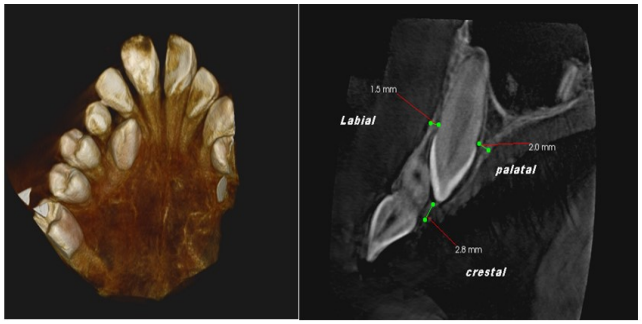

Figure 1a. CBCT image of a palatally impacted canine 1b: Figure showing anatomic limits with respect to the impacted canine

AS AN AID IN TEMPORARY ANCHORAGE DEVICE PLACEMENT: TADs are often used to provide absolute anchorage for the patient. Because of the varied site of placement of TADs, it's only wise to protect the surrounding structures to avoid iatrogenic damage to the roots of adjacent teeth or vital anatomic structures. These CBCT images can prove helpful for macro anatomical analyses through visualization of neighboring structures such as tooth roots, sinuses, and nerves that can be valuable for avoiding damage or complications. CBCT can also be useful for microanatomical evaluation of the quantity and quality of cortical bone and quality of the underlying trabecular bone that may determine the primary stability of TADs, which in turn, is relevant to their secondary stability over the longer term.[4]

ASSESSMENT OF CLEFT LIP AND PALATE DEFECTS AND OUTCOME OF ALVEOLAR BONE GRAFTING: The most common craniofacial anomaly in humans which requires attention from specialists in various disciplines can only be sufficiently understood with the help of a three-dimensional view. CBCT is essential in the treatment of cleft to understand the extent and severity of the defect, the presence of impacted teeth if any, the quality of bone, and diagnosing for implant placement. CBCT images are valuable for determining the volume of the alveolar defect and, therefore, the amount of bone needed for grafting in patients with CL/P and for determining the success of bone fill following surgery. Figure 2 shows a CBCT image of a right-side maxillary complete cleft.

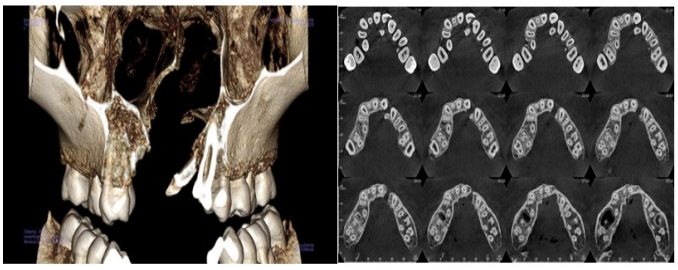

Figure 2. CBCT image of a right-sided maxillary cleft

AIRWAY MORPHOLOGY AND OBSTRUCTIVE SLEEP APNEA: The use of CBCT in orthodontics is an emerging science as it provides a 3D and volumetric analysis. It plays a vital role in the diagnosis of Obstructive sleep apnea and enlarged adenoids which are primary concerns in cases of long-face syndrome.[6]CBCT has been used to investigate the effects of Rapid Maxillary Expansion on constricted airways. RME has been shown to increase maxillary and nasal widths but not pharyngeal airway volume.[7] Similarly, the effect of Orthognathic surgeries on the airway volume was assessed, and was concluded that class II correction increased the airway volume whereas the class III correction decreased the airway volume.[8,9]

DIGITAL MODELS: Intra-oral scanning would give a picture of the clinical crown but integrating it with CBCT will help us assess the position and angulation of the root in relation to the crown thus helping in planning treatment in clear aligner therapy. [10]

AS AN AID IN ASSESSING TMJ PATHOLOGY: CBCT helps in the visualization of minor to overt pathological changes that go unnoticed with 2D conventional radiographs. While CBCT alone without accurate history and clinical findings cannot substantiate a diagnosis,a recent study confirmed that are more likely to change their diagnosis of TMJ disease after viewing CBCT images of symptomatic subjects.[11]Infrequent pathologies such as condylar hypo/hyper/aplasias, adverse morphological and functional changes that include progressive bite changes, dental and skeletal compensations and limitation or deviation of jaw movements that contribute to unpredictable orthodontic outcomes. These adverse effects cause problems in transverse, vertical, and sagittal directions.

AREAS REQUIRING FURTHER STUDY: Despite promising and anecdotal support of 3D imaging over 2D radiography, the ultimate question is the true impact of the measurable qualitative and quantitative impact of the data in modifying and enhancing diagnosis and refining treatment plans. CBCT has helped in expanding horizons about studies related to alveolar housing and root morphology thereby aiding in understanding the biomechanics of tooth movement. In addition, CBCT throws light on important and pertinent questions such as tooth ankylosis which requires a definitive diagnosis to start orthodontic treatment. Lastly, CBCT can answer numerous questions on broader thematic areas such as orthognathic surgery, TMJ disorders, Cleft lip and palate, craniofacial anomalies, developing asymmetries, airway morphology, and Obstructive sleep apnea.[12]

CONCLUSION

Since its introduction into dentistry in 1998, CBCT has revolutionized treatment planning and diagnosis in clinical orthodontics. To date, this applies to impacted teeth, CL/P and orthognathic or craniofacial surgery patients. CBCT on other types of cases can also be performed where there is likely to be a positive benefit-to-risk outcome such as supernumerary teeth, identification of root resorption caused by unerupted teeth, evaluating boundary conditions, TMJ degeneration and progressive bite changes and for placement of TADs in complex situations. Based on research evidence, orthodontists are advised to use their best clinical judgment when prescribing radiographs, including CBCT scans, to obtain the most relevant data using the least ionizing radiation possible.

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