Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4527 - 4532
Received 05 March 2021; Accepted 01 April 2021.

CBCT: The Third Eye in Orthodontics

Dr. Monalisha Bose[1], Dr. Poonam Agrawal[2], Dr. Dinesh Kumar Bagga[3] Dr. Ritika Gupta[4]

[1]Student, Department of Orthodontics and Dentofacial Orthopaedics,School of Dental Sciences, Sharda University, Greater Noida, UP.
[2]Professor Department of Orthodontics and Dentofacial Orthopaedics,School of Dental Sciences, Sharda University, Greater Noida, UP.
[3]Head of the Department and Professor, Department of Orthodontics and Dentofacial Orthopaedics,School of Dental Sciences, Sharda University, Greater Noida, UP.
[4]Senior Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Seema Dental College and Hospital, Rishikesh

ABSTRACT
The comparison of CBCT to the third eye is an analogy often kept in mind before the commencement of a complex orthodontic procedure.

CBCT is an insurmountable procedure in the field of dentistry which pinpoints the specific cause of the anomaly so that it is easier for the orthodontist to come up with a better treatment plan.

Keywords: CBCT,3D imaging technology, Orthodontic diagnosis

INTRODUCTION

Accurate diagnostic imaging of the craniofacial complex is not only an essential factor but also an indispensable procedure that helps the orthodontist to come up with a proper diagnosis and treatment planning. The standard imaging techniques in dentistry include two-dimensional (2D) interpretation of three-dimensional (3D) figures which are often hampered by various technical hindrances like magnified, distorted, superimposed and misrepresented radiographs of the biological structures.

In dentistry, the demand for providing an accurate, low distortion, and high resolution three dimensional (3D) craniofacial imaging can be achieved with the implementation of CBCT. Contrary to the standard CT, which uses a fan-shaped beam to create multiple thin slices, the CBCT uses a cone-shaped X-ray beam. The CT imaging procedure has a higher dose of radiation exposure than a two-dimensional (2D) scan. CBCT has an image accuracy perk over the standard imaging, which results in improved visualization. CBCT produces panoramic and cephalometric images in 3D when the collected data is reformed in a volume.

CBCT is an exponential advanced procedure that provides the orthodontist with the best diagnostic fidelity of periapical, panoramic, cephalometric, occlusal radiographs, and TMJ series. It also produces views of cephalogram for both right and left sides.

Justification, optimization, and dose limitation are the three fundamental principles of radiation which should be kept in mind when opting for radiation exposure due to an orthodontic rationale. As children are highly vulnerable to ionizing radiation, exposure to radiation should be kept as low as possible while attaining a valid diagnostic information. According to the SEDENTEXCT guidelines, it is not feasible to distinguish between secure and deleterious exposure due to the precariousness associated with the stochastic effects. Potential risk can be associated with even the smallest amount of radiation.

With the evolution of technology, CBCT still holds a great privilege in orthodontic diagnosis and treatment planning. CBCT promises to treat patients with dentofacial deformity more confidently with surgical technology, creating better esthetics. This article presents a summarized review of how CBCT plays a vital role in different fields in orthodontics, making better diagnosis and therapy.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4527 - 4532
Received 05 March 2021; Accepted 01 April 2021.

PRAGMATIC UTILIZATION OF CBCT IN ORTHODONTICS

Impacted Tooth Location

In orthodontics, it is quite essential to determine the position of an impacted or transposed tooth, which is mostly seen in unusual places. CBCT imaging in orthodontics is most commonly indicated for the evaluation of an impacted tooth position. CBCT imaging gives a more accurate information to determine the location and placement of the teeth and the stages of development to decipher the precise angulation of the impacted canine.[3] The 3D images have a high potential

in establishing the propinquity of adjacent teeth roots and adjacent structures. If the CBCT volume is collimated to the impacted tooth, the benefit-risk ratio is considered favorable.

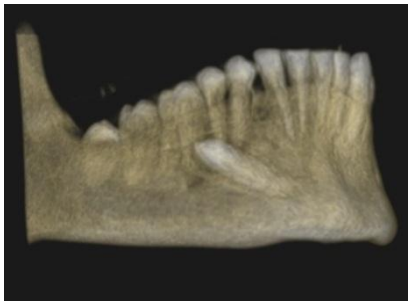

Figure 1 CBCT images showing the relationship of the impacted canine with adjacent teeth

Root Resorption

Root resorption is very commonly noticed during an orthodontic treatment, which can be assessed routinely by Orthopantomograms and intraoral periapical radiographs. Still, CBCT produces high-definition images which aids the clinicians to categorize the type of root resorption that orthopantomograms and intramural periodical radiographs cannot provide, for example, teeth having two or more root resorption is mostly confined to a particular root.[5]

Figure 2 CBCT images showing root resorption of deciduous molars and position of the permanent premolar and canine.

Cleaved Roots

Cleaved roots in an oblique direction may be difficult to view radiographically. CBCT techniques can show the concerned tooth in all three planes of space. With CBCT, the exact location of root fracture and the angulation of displacement can be established.[6]

Orthodontic Implant Placement

The success of orthodontic implants depends upon the knowledge of root positioning.[7] CBCT provides more accurate view of the inter radicular site providing proper guidance for mini-implant insertion between the roots of adjacent teeth in physically onerous sites.[8] The bone volume and its attribute can be evaluated with reasonable accuracy in the placement before the installment of the mini-implants.[9,10]

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4527 - 4532
Received 05 March 2021; Accepted 01 April 2021.

Site of Anatomic Structures

CBCT imaging gives a precise information about the anatomical framework in all the three planes (sagittal, coronal, and transverse). It also provides an accurate measurement of area, distance and volume of the anatomical structures that aids the orthodontists to come up with a better treatment plan. Several studies have indicated that CBCT scans provide a better cephalometric measurement in contrast to a conventional cephalogram.

Furthermore, the conventional cephalogram is barred to represent 3 dimensional structures onto a 2D plane. CBCT generated cephalograms are more beneficial as compared to conventional radiographs in recognizing bilateral landmarks such as gonion, condylion and orbitale, as they are often superimposed in conventional cephalograms.[18]

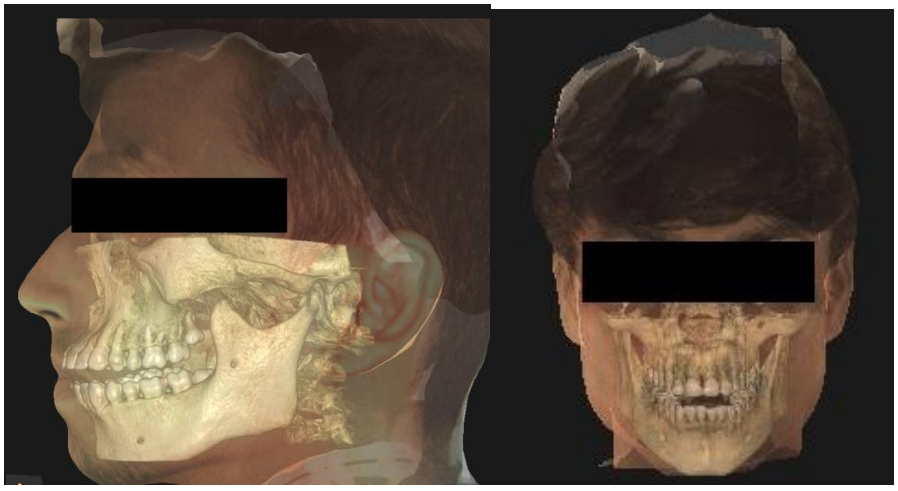

Figure 3 CBCT image of facial scans.

ASYMMETRY EVALUATION

It is essential in orthodontics to assess the facial symmetry for better esthetic results. Many articles have reported a relationship between malocclusion and craniofacial asymmetry.

A study conducted by Alavi et al. reported that Class II subdivision patients are commonly presented with mandibular asymmetry. CBCT image provides unique results to assess facial asymmetry. The built-in reconstruction algorithm is used by these 3D images that correct distortions produced due to projection geometry. Landmarks in one/two planes of space can be easily identified, but identifying landmarks in the third plane is challenging, achievable by CBCT.

CBCT holds the following advantages in landmark identification-

I. Lack of superimposed structures.

II. Images produced are not plagued by geometric distortion.

III. Easiest visualization.

Temporomandibular Joint Assessment

CBCT provides diagnostic accuracy and reliability for the evaluation of osseous TMJ abnormalities as compared to conventional tomography. In 2005, the first study showing that CBCT can produce TMJ dimensions of accurate and reliable measurements was published. Recent studies have confirmed the accuracy of CBCT in TMJ evaluation, concluding that joint spaces have similar measurements to actual joint spaces. The bone morphology of mandibular condyles can be easily traced or detected by CBCT images. CBCT is useful in detecting bone diseases such as juvenile idiopathic arthritis, condylar hyperplasia, intra-articular disorder osteochondroma of the mandibular condyle, synovial chondromatosis and many other joint related diseases. CBCT is the supreme method to render many anatomic variations

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4527 - 4532
Received 05 March 2021; Accepted 01 April 2021.

one of which is the evaluation of the cortical erosions in the articular eminence which is highly challenging due to the pneumatization of the temporal bone.

Airway Analysis

Lateral cephalograms are commonly used for airway analysis, which provides a 2D image whereas the CBCT technology provides 3D and volumetric analysis of the airway which can easily detect complex anomalies such as obstructive sleep apnea (OSA) and enlarged adenoids, facilitating in better diagnosis and treatment planning.[11,12] Apnea-affected subjects are often recorded with significant decrease in airway area, volume and distance, underlining the value of CBCT in diagnosing this condition which cannot be recorded in lateral cephalograms.

Cleft Lip and Palate evaluation

Three-dimensional imaging for patients with cleft lip and palate is essential for both preoperative and therapeutic evaluations. It is difficult to obtain the estimated dimensions of the bony defects and their relationship to other critical anatomical structures. [13] CBCT allows preoperative assessment of the volume and location of the bony defects in patients with cleft palate.[14] CBCT guides the clinician to plan grafting procedures or surgical procedures necessary for correcting the bony defects.

ORTHOGNATHIC SURGERY

CBCT has made it easier to treat patients with dentofacial deformity with surgical technology. Before CBCT, orthodontic camouflage was the only option that was widely accepted, which resulted in esthetically compromised results.

Malocclusion associated with jaw discrepancy can be treated in 3 ways-

I. Growth modification

II. Camouflage

III. Orthognathic surgery

After the growth is completed, surgery remains the only option to correct a severe jaw discrepancy. With an excellent software CBCT accurately examines both hard and soft craniofacial tissues along with their spatial relationships which is important for planning an orthognathic surgery. In patients with skeletal malformations and traumas, preoperative surgical planning and simulation can be carried out with the help of CBCT 3D surface reconstructions of the jawbones. [18] Other interventions such as osteotomies, simulations of virtual repositioning of the jaws, distraction osteogenesis can be easily obtained.

Treatment options can be recreated or checked with the help of virtual models of anatomical structures fabricated from CT volumes and registered in a 3-dimensional image data which are capable of creating anatomically correct substitute grafts. CBCT helps the clinician to execute a proper diagnosis as it is highly significant to have an appropriate treatment planning as there are many limitations associated with surgical procedures.

CBCT reconstructed Cephalograms

The 3D CBCT data can be accustomed to produce a CBCT generated lateral cephalogram. These CBCT reconstructed lateral cephalograms can be used for conventional measurements and can also be compared with existing 2-dimensional norms.[15] Cases in which patients have not undergone scanning with the proper head position, these CBCT reconstructed lateral cephalograms can be used to reorient the head position digitally. Separate images of the left and right sides are obtained with CBCT reconstructed lateral cephalograms.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4527 - 4532
Received 05 March 2021; Accepted 01 April 2021.

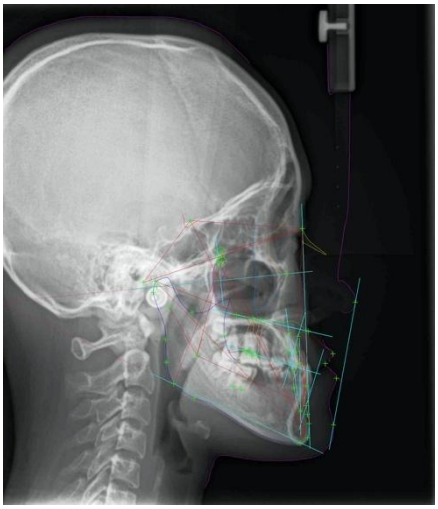

Figure 4 CBCT reconstructed lateral cephalogram

CONCLUSION

CBCT is an exponential advancement that holds the capability to improve orthodontic diagnosis and treatment planning. Considering the risks of CBCT, which outweigh the benefits in orthodontics, CBCT should only be advised when necessary, i.e., its use should be case-specific in which the clinician should be able to justify the reason for CBCT acquisition. With the advancement of technology, CBCT is boundless in changing future orthodontics w.r.t the clinical assessment of patients.

REFERENCES

1. Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. Am J Orthod Dentofacial Orthop 2005;128(4):418-23.
2. Chaushu S, Chaushu G, Becker A. The role of digital volume tomography in the imaging of impacted teeth. World J Orthod 2004; 5:120-32.
3. Heimisdottir K, Bosshardt D, Ruf S, Can the severity of root resorption be accurately judged by means of radiographs? A case report with histology. Am J Orthod 2005;128(1):106-09.
4. Melo SL, Bortoluzzi EA, Abrea MJ, et al. Diagnostic ability of a cone beam computed tomography scan to assess longitudinal root fractures in prosthetically treated teeth. J Endod 2010 Nov;36(11):1879-82.
5. Peck J, Sameshima G, Miller A, et al. Mesiodistal root angulation using panoramic and cone beam CT. Angle Orthod 2007;77(2):206-13.
6. Kim S, Choi Y, Hwang E, et al. Surgical positioning of orthodontic mini-implants with guides fabricated on models replicated with cone-beam computed tomography. Am J Orthod Dentofacial Orthop 2007;131(4 Suppl):S82-89.
7. Macchi A, Carrafiello G, Cacciafesta V, et al. Three-dimensional digital modeling and set up. Am J Orthod Dentofacial Orthop 2006;129(5):605-10.
8. Wong B. Invisalign A to Z. Am J Orthod Dentofacial Orthop 2002;121(5):540-41.
9. Sforza E, Bacon W, Weiss T, Thibault A, Petiau C, Krieger J.Upper airway collapsibility and cephalometric variables in patients with obstructive sleep apnea. Am J Respir Crit Care Med 2000;161(2, pt 1):347-52.
10. Ghoneima A, Kula K. Accuracy and reliability of cone beam computed tomography for airway volume analysis. Eur J Orthod 2011 Aug 10.

11. Hamada Y, Kondoh T, Noguchi K, et al. Application of cone beam computed tomography to clinical assessment of alveolar bone grafting: A preliminary report. Cleft Palate Craniofac J 2005; 42:128-37.
12. Wortche R, Hassfeld S, Lux CJ, et al. Clinical applications of cone beam digital volume tomography in children with cleft lip and palate. Dentomaxillofacial Radiol 2006:35;88-94.
13. James KM, John CH, Hyeran C. Practical applications of cone beam computed tomography in orthodontics. J Am DA 2010;141(3):7S-13S.
14. Zamora N, Llamas JM, Cibrian R, et al. Cephalometric measurements from 3D reconstructed images compared with conventional 2D images. Angle Orthod 2011 Sept;81(5):856-64.
15. Gribel BF, et al. Accuracy and reliability of craniometric measurements on lateral cephalometry and 3D measurements on CBCT scans. Angle Orthod 2011 Jan;81(1):26-35.
16. Agrawal JM, Agrawal MS, Nanjannawar LG, Parushetti AD. CBCT in Orthodontics: The Wave of Future. J Contemp Dent Pract 2013;14(1):153-157.
17. Machado GL. CBCT imaging - A boon to orthodontics. Saudi Dent J. 2015;27(1):12-21.
18. Cevidanes LHS, Bailey LJ, Tucker GR, Styner MA, Mol A, Phillips CL, et al. Superimposition of 3D cone-beam CT models of orthognathic surgery patients. Dentomaxillofac Radiol 2005 Nov;34(6):369-75.
19. Cevidanes LHS, Bailey LJ, Tucker SF, Styner MA, Mol A, Phillips CL, et al. Three-dimensional cone-beam computed tomography for assessment of mandibular changes after orthognathic surgery. Am J Orthod Dentofacial Orthop 2007 Jan;131(1):44-50.
20. Mah J. The evolution of digital study models. J Clin Orthod 2007;4(9):557-61.
21. Kau CH, Littlefield J, Rainy N, et al. Evaluation of CBCT digital models and traditional models using Little's index. Angle Orthod 2010 May;80(3):435-39.
22. Van Vlijmen, O.J. Berge , S.J Swennen, G.R. Bronkhorst, E.M. Katsaros, C Kuijpers-Jagtman. Comparison of cephalometric radiographs obtained from cone-beam computed tomography scans and conventional radiographs. J. Oral Maxillo-fac. Surg.2009; 67 (1):92–97.