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CONE BEAM COMPUTERIZED TOMOGRAPHY – IN PEDIATRIC DENTISTRY

Pediatrics

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ABSTRACT

An emerging X-ray technology applied in dento-maxillofacial imaging is cone beam computerized tomography (CBCT). CBCT provides 3 –dimensional imaging of more complex and more accurate imaging when compared to conventional and digital radiology. Accurate information required for diagnosis, treatment planning, and post-treatment evaluation can be gathered with CBCT system available with small field of view images and at low dose. When it comes to pediatric dentistry radiation dose should be considered. Although radiation dose from CBCT is low in comparison to conventional Computerized tomography(CT), radiation risk to patient should be assessed and quantified. This article provides an overview of applications of CBCT in pediatric dentistry.

KEYWORDS

Cone beam computerized tomography, Pediatric dentistry, radiation dose consideration, Field of view, 3-dimensional imaging.

INTRODUCTION:

Radiographs are very important diagnostic tool, especially in the oral health care of infants, children, adolescents, and individual with special health care needs. The first radiograph was taken in the year 1896, and since then two-dimensional imaging modalities came into existence in dentistry. [1] But there were some limitations of 2-dimentional radiographic images due to which sometimes diagnosis becomes difficult. One of the major advancement in the field of radiology is the Cone Beam Computed Tomography which is capable of capturing both skeletal and soft tissue, and providing them in three dimensional images that can be displayed together or separately. [2] Attilio Tacconi, Piero Mozzo, Daniele Godi and Giordano Ronca are the pioneers of this technology.[3] In 1988, Cone Beam Computerized Tomography(CBCT) was introduced in dentistry. [4] CBCT is referred to as multiplanar reformation (MPR) process as it allows the creation in 'real time' of images in axial plane and also two- dimensional (2D) images in the coronal, sagittal and even oblique or curved image planes. CBCT provides three-dimensional information as CBCT data can be reformed in a volume, than in a slice. [5]

Fig-1 Cone Beam Computerized Tomography

The use of unit can be designed depending on the available or selected scan volume height as follows:

1. Localized region (limited field, small field or focused field)– approximately 5 cm or less
2. Single arch- 5cm to 7 cm
3. Inter-arch- 7 cm to 10 cm
4. Maxillofacial- 10 cm to 15 cm
5. Craniofacial- greater than 15cm

In general, smaller the scan volume, the higher the resolution of the image. [8]

Role Of Imaging In Pediatric Dentistry:

From the early days of dental radiographs, the concepts did not change significantly until 3-dimensional imaging was introduced in 1980's. Computed tomography was available for 3-dimensional dental imaging, but utilization was limited to management of craniofacial anomalies, complex surgeries, and other unique dental situations due to its high cost, limited access, and radiation exposure.[4] Due to its 3-dimensional imaging and ability to provide images of high resolution, ability to reform 2-dimensional images into 3-dimensional images is gaining popularity in dentistry.

Radiographs of children reveal many conditions which cannot be discovered by any other means. Moreover radiographic examination enables the clinician to establish a therapeutic decision.

1] Pre-operative imaging: Pathologic alterations and dental and alveolar hard tissue morphology can be visualized that can help to reach a correct diagnosis. [8] Eruption pattern of teeth, anomalies in number or shape of teeth can also be evaluated with the help of CBCT. CBCT can help clinician's plan of eruption guidance, and serial extraction customized to individual patients. It allows to determine the site and location of resorption whether lingual or facial there by helping in treatment planning of such tooth.[9] Morphology of the tooth including location and number of canals, pulp chamber size and degree of calcification, root structure, direction and curvature, fractures, iatrogenic defects, and the extent of dental caries can be determined. [8]

2] Intra-operative procedures: During pulp therapies like pulpotomy, in apexification, apexogensis, and in pulpectomy procedures. Intracanal content debridement can be ensured weather mechanical debridement is up to the apical terminus of canal and weather the obturation is dense, homogenous, and contained within the root canal. [8]

3] Post- operative: Potential obstacles to retreatment can be evaluated more over delayed healing and results of therapy can also be very evaluated, as well as surgical considerations.

Radiation Dose Consideration For Pediatric Patients:

CBCT imaging is associated with a higher radiation dose to the patient than panoramic and intra-oral imaging but a lower patient dose than conventional single and multi slice CT [9, 10]. Although radiation dose from CBCT is low relative to conventional CT, the radiation risk to the patient should be assessed and quantified. The radiation risk can be estimated by calculating the effective dose, which is a radiation quantity proposed by the International Commission on Radiological Protection (ICRP). [11] Children are more sensitive to radiation than

adults because the number of dividing cells promoting DNA mutagenesis is higher and they have more time to express any radiation induced effects, such as cancer. There is an order of magnitude increase in cancer risk between children and adults, and there is also a significant difference between boys and girls, with the latter being more radiosensitive. [12,13]

According to C Theodorakou, A Walker, K Horner et al evaluated the effective doses for pediatric dental CBCT. Even though the pediatric effective doses were considerably lower than they were for head and neck multi slice CT, it was found that they were higher than those for conventional dental X-ray imaging and similar to those for adult CBCT doses.The lowest effective doses were calculated for units that offered small fields of view and "small patient size" settings. Therefore, dose reduction can be achieved by using the pediatric or small patient size settings. Small and medium fields of view should be used for mandible and/or maxilla imaging, while for CBCT units which offer only large fields of view, vertical and horizontal collimation should be offered. Taking into account the higher radio sensitivity of children, it is imperative that the use of CBCT in children is fully justified over conventional X-ray imaging.[14]

The Major Advantages Of Cbct In Pediatric Patients: [15]

- Less scan time and less complicated apparatus , reduce anxiety in children, leads to less motion artifacts and also reduces the cost as compared to CT
- Images obtained with CBCT are sharp, with less distortion.
- As compared to conventional CT,CBCT causes lesser distortion
- Radiation dose of CBCT is higher, when compared to intra-oral radiography, but dose reduction can be achieved between the range of 96% and 51% compared with conventional head CT.

Principles in use of CBCT in dental and maxillofacial radiology have been elaborated by American Dental Association Council on Scientific Affairs in 2012, [16] National Council On Radiation Protection and Measurements (NCRP) report no 145 [17,19,20]

Cbct Applications In Pediatric Dentistry

1**. Evaluate eruption pattern**: Tooth development is a complex phenomenon and conventional imaging does not give a clearer picture. Eruption pattern of the teeth can be evaluated with the help of CBCT, anomalies in number or shape of teeth can also be evaluated. This can help clinician to properly plan for eruption guidance, and serial extraction customized to individual patient. The exact site of resorption can be determined which can help in cases of lingual resorption or facial side resorption of the tooth. [1]

2. Bony pathosis: CBCT can be helpful in determining the cystic lesions, various bony pathologies like tumors or infections in maxillofacial regions. As CBCT provides multiplanar view it gives important information on size, exact location and cortical expansion. CBCT is also helpful in follow-up cases. [21]

3. Traumatic injuries: Traumatic injuries of jaws can be better assessed with CBCT. Multiple jaw fractures, fractures with bone displacements can be very well evaluated with CBCT, when considering the radiation dose and image quality. CBCT is an alternative to conventional CT for complex jaw fractures. [24] It is very difficult to diagnose non-displaced fracture of mandibular condylar region with conventional radiographs. As CBCT provides multiplanar view it helps in better assessment of intra-articular fractures of condylar head. CBCT is helpful in diagnosis of traumatic injuries. [21,22]

4. Craniofacial disorders: Children with cleft palate [23] ,various facial deformity require surgical treatment. CBCT is very helpful for patient/parent educations facilitates clinicians for properly planning the treatment and keep follow-up to evaluate development, growth and function of patient. Only alveolar cleft can be identified in cases with cleft palate patient with panoramic radiographs but CBCT helps in visualization of the entire osseous defect. It helps in assessments of deviation of the nasal septum, degree of fusion of palate, tooth proximity to the cleft, width of the cleft. As CBCT provides 3D reconstruction it facilitates the evaluation of developmental defects, syndromes and maxillofacial defects like cleft. [21]

5. Detecting foreign bodies in the maxillofacial region: Multi detector CT or MDCT are almost non diagnostic when it comes to extensive bridgework and metal restoration. Artifacts arise from convention CT scan from metal restoration. Such artifacts are lower with CBCT.[24,25]CBCT is better imaging modality to assess metal object in fact, [24,26] ,facilitates retrieval of broken instrument from canal, broken dental needle or surgical wires.

6. TMJ disorders: TMJ radiographic projection may be useful in many clinical situations in TMJ disorders. But due to overlapping of many anatomic structures bony alterations like osteophytes, pneumatization of articular eminence and erosions are difficult to diagnose. CBCT may be useful in this. [27,28]

7. Airway analysis: A significant difference has been demonstrated by CBCT in measurements of airway volume and the anterioposterior dimension of the oropharyngeal airway in conditions like obstructive sleep apnea. [29]

8. Caries diagnosis: Akdeniz et al. compared the accuracy of limited cone beam computed tomography, an image plate system and F-speed film in assessing the depth of proximal carious lesions and concluded CBCT method appears to be a promising tool for detection and monitoring of proximal carious lesions. [30]

9. Soft tissue analysis: With the help of CBCT separate images of right and left can be created to visualize the asymmetries. Head can be tilted and rotated in infinite number of position to evaluate symmetry of the soft tissue [31]

10. Detection of supernumerary and impacted teeth(fig 2): Most common teeth to be impacted is maxillary canine, followed by permanent second molar which can also get impacted due to abnormal position of third molar in the alveolar bone. Supernumerary teeth such as mesiodens may often be present with impacted teeth. So CBCT can be broadly used for diagnosing impacted teeth in pediatric patients. [31]

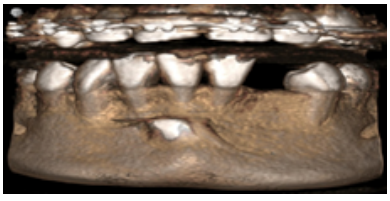

Figure: 2 3-Dimensional image of impacted tooth

CONCLUSION:

CBCT is becoming popular in many branches of dentistry as it provides 3-dimensional view and significant information's of complex structure where 2-dimensional imaging does not provide sufficient information due to its certain limitations. CBCT is most frequently applied in oral maxillofacial surgery, implant dentistry, orthodontics, endodontic. When it comes to pediatric dentistry consideration is of radiation dose. Effective dose of CBCT is less compared to conventional CT, but higher than those of conventional dental X-ray imaging. So dose reduction should be achieved by using pediatric or small size setting, thyroid collar during CBCT. Thyroid collar reduces dose by 40 to 50 % to thyroid and esophagus. CBCT may be very helpful in certain clinical situations like cleft palate craniofacial deformities, helpful in evaluation of eruption patterns, supernumerary tooth, impacted tooth, in bony pathosis, TMJ evaluation and various other clinical situations. Benefits should outweigh the risk always.

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