Review Article

Cone beam computed tomography in pediatric dentistry

S. Jayajanani[1], Ganesh Jeevanandan[1], P. Jayashri[2]*

ABSTRACT

The high prevalence and increase in the number of children receiving dental treatment are very high. For many years, two-dimensional (2D) modalities such as periapical radiographs, cephalometric, and panoramic radiographs were used for diagnosis and treatment planning in dentistry. This 2D representation left some difficulties in diagnosis and treatment planning in dentistry. Thus, evolution toward 3D modalities was desired. This 3D technology has been used popularly in all fields of dentistry, but its application in pediatric dentistry has remained unexplored. In this article, we attempt to discuss the applications of cone beam computed tomography among pediatric patients.

KEY WORDS: Applications, Cone beam computed tomography, Pediatric dentistry

INTRODUCTION

As a clinician, to make diagnosis and come to conclusion about the treatment plan based on the clinical examination alone is very difficult. Hence, the radiographic diagnosis has been introduced. Various diagnostic tools such as imaging play a key role in diagnosis in the dental practice. The periapical radiographs are widely used among other imaging techniques.[1] The periapical radiographs help in assessing dental caries surrounding anatomical structures, lesions, etc. However, this scenario changed with the introduction of panoramic radiography in 1960's.[2] The panoramic radiograph has provided the clinicians with best images such as single comprehensive image of jaws and maxillofacial structures and also proper anatomical structures with lesser radiation when compared to full mouth periapical radiographs.[3] But these techniques have a drawback of providing two-dimensional images (2D) of 3D structures. This can lead to a magnification of images, distortion of anatomical structures, superimposition, and misrepresentation of structures and finally an improper diagnosis. This led to a search of technology with 3D projections. Various imaging modalities such as magnetic resonance imaging,[4] ultrasound,[5] and computed tomography (CT) have been introduced. These modalities have provided the clinicians with high resolution of images of the oral structures and have helped out in detecting early dental abnormalities. Among this, CT has been widely available since a long time, but its application in dentistry is limited due to its high cost, dose considerations. Recently, however, cone beam CT (CBCT) has become a viable option for the dental office with the convergence of technology and affordability as compared with conventional CT. The term cone beam CT is derived from the cone-shaped beam being used unlike the conventional CT, which utilizes a fan-shaped beam.[2] The volume data of the human body can be acquired in a single rotation of the beam and sensor. Slice by slice axial, sagittal, and coronal images are observed with both conventional CT and CBCT with the major difference being the incorporation of reference lines in CBCT, which makes it easier to locate the slices.[3]

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SUPERNUMERARY TEETH/ IMPACTED TEETH DIAGNOSIS

The supernumerary tooth is an anomaly which leads to failure in the eruption of adjacent teeth and leads to crowding and displacement of the adjacent teeth, root resorption, and even cyst formation. Radiographs are used in detecting the supernumerary teeth.

[1]Department of Pedodontics and Preventive Dentistry, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India, [2]Department of Public Health Dentistry, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India

***Corresponding author:** Dr. P. Jayashri, Department of Public Health Dentistry, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, 162, Poonamallee High Road, Velappanchavadi, Chennai – 600 077, Tamil Nadu, India. Phone: +91-9841788803. E-mail: shrijaya2009@gmail.com

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Among other radiographs, CBCT plays a key role in detecting the exact location of the supernumerary teeth. In pediatric dentistry, the application of CBCT technique can be helpful in detecting the exact location of supernumerary and impacted teeth and inappropriate treatment planning. CBCT offers an undistorted view of the dentition that shows the details of individual dental morphology, including missing, supernumerary and anomalous teeth, as well as the 3D spatial orientation of the teeth and roots [Figures 1-3]. CBCT imaging enables the clinician to evaluate eruption patterns and their variations with an improved accuracy compared to that of conventional radiographs.[6] The use of CBCT has proven useful in the management of children with supernumerary teeth. CBCT images can be used to locate the precise position of impacted and supernumerary teeth and to make an accurate diagnosis and design treatment strategies that would result in less invasive surgical intervention.

Figure 1: Cone beam computed tomography coronal image showing impacted tooth with supernumerary teeth

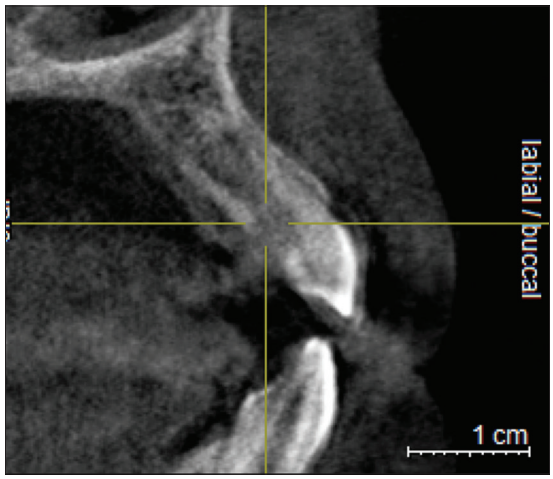

Figure 2: Cone beam computed tomography sagittal image showing impacted tooth

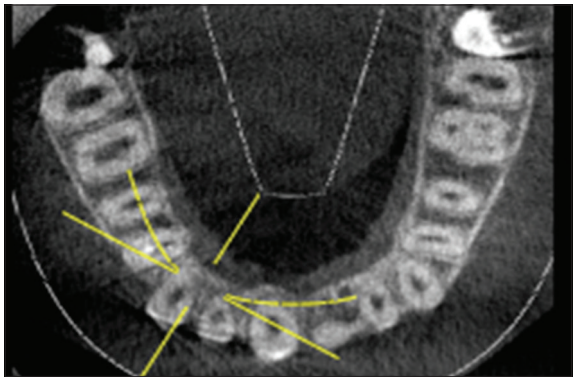

Figure 3: Cone beam computed tomography axial image showing impacted tooth

AIRWAY SPACE DEFORMITIES

Heredity has an important function in determining the size and shape of the face; however, environmental factors such as breathing habit are essential for the balanced development of the craniofacial complex. Some dentofacial deformities are associated with the mouth breathing habit. According to Melvin Moss' functional matrix theory,[7] nasal breathing allows proper growth and development of the craniofacial complex interacting with other functions such as masticatory and swallow. On the other hand, when nasal obstruction leads to mouth breathing habit, this could result not only in changes of the tongue and lip positions but also causes mouth opening posture, downward and backward rotation of mandible, long face, constricted maxillary arch, incompetent lip seal, flat noses, and narrow nasal base.[8-12] Predisposing factors of nasal obstruction can include adenoid and tonsil hypertrophy, polyps, allergies, infections, and nasal deformities.[10] Conventionally, the airway space has been evaluated by the use of cephalometric radiographs, however, this method results in superimposition of all bilateral structures of the craniofacial complex. Nowadays with the advent of CBCT, the airway evaluation became more accurate and reliable, generating information more comprehensive than the 2D radiographs.[13,14]

Cleft Lip and Cleft Palate

The information regarding the number and orientation of the teeth, dental and skeletal age and the amount and quality of bone available in the cleft region is considered vital for the clinical management of the patients with cleft lip and cleft palate. Panoramic radiographs are often used to assess the number of missing teeth and to determine the dental and skeletal age in cleft lip and cleft palate patients. However, the amount and quality of the available bone cannot be accurately assessed using panoramic radiographs. Cleft lip and palate CBCT can provide the exact anatomic relationships of the osseous defect and bone thickness around the existing teeth in proximity to the cleft or clefts.[15]

Trauma

The malformed, hypoplastic crown or root is due to the injury to the primary tooth which affects the

underlying permanent tooth germ. The degree and nature of malformation depend on the injury. These types of traumatic cases can be diagnosed using 2D radiographs, but some cases require more advanced 3D imaging such as CBCT.[16]

Osteomyelitis (OM)

OM of the jaws is a disease which is often difficult to diagnose. OM is usually diagnosed with panoramic radiographs or intraoral radiographs to make the diagnosis. Further, imaging through CT is accurate at detecting not only typical alterations inside the bone but also periosteal reactions and soft tissue involvement. It is also helpful to determine the extension of the involved bone and the relationship to adjacent anatomical structures. With available CBCT systems, high-contrast structures can be visualized almost equal to bone window CT combined with reduced radiation exposure. This will result in an increasing number of indications that are evaluated with CBCT instead of CT.[16]

Soft-tissue Analysis

Using the soft-tissue data gathered in the CBCT scan, it is possible to rotate and tilt the head in an infinite number of positions to evaluate symmetry of the soft tissue. Surface area and volume analysis have also been possible through 3D software such as *in vivo* which aid in evaluating facial symmetry.[17]

DIAGNOSIS OF HARD TISSUE LESIONS OF THE ORAL CAVITY

It can provide valuable information regarding cystic lesions and their extent, various bony pathologies such as tumors, fracture lines in case of traumatic injuries, condensing osteitis, and focal apical osteopetrosis. The latter is also useful in determining the limitation to tooth movement in case orthodontic treatment is required.[18]

DIAGNOSIS OF ROOT FRACTURES AND ROOT RESORPTION

Conventional radiography is adequate for examination of structures such as the tooth crown, root, and surrounding structures; however, difficulties are faced in the diagnosis of root fractures and internal and external resorption.[17-19] Use of cone beam volumetric tomography has been useful for the diagnosis of fractures.[20,21]

Caries Diagnosis

The detection of proximal and occlusal surface caries by conventional intraoral 2D methods has demonstrated only low-to-moderate sensitivity, but slightly better specificity, and high observer variability.[22-28] CBCT imaging appears to be the best prospect for improving the detection and depth assessment of caries in approximal and occlusal lesions.

Assessment of root canal anatomy

Anatomical variations exist with each type of tooth.[29,30] The 2D nature of radiographs means that they do not consistently reveal the actual number of canals present in teeth.[31-33] This may potentially lead to the inability to identify all the roots present, potentially resulting in incomplete disinfection of the root canal system, which may ultimately lead to a poorer outcome of root canal treatment.[34] CBCT is a useful addition to the endodontist's armamentarium for identifying root canals;[35,36] however, it should only be reserved for cases where root canal anatomy cannot be fully appreciated with other radiographs.

CONCLUSION

CBCT has many useful role to play in the assessment of dental and maxillofacial disorders. Many evidences suggest that CBCT could replace conventional 2D imaging. When considering such a shift in imaging strategy, dose and costs must come into consideration especially in children. However, the use of CBCT in children should be justified depending on the case such that its application outweighs the potential risks of radiation exposure and all the basic principles should be followed apparently.

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