“CBCT” An Innovative tool in Pediatric dentistry: A Review

Introduction:
Although nothing can replace history and physical examination when evaluating patients, the use and evolution of non-invasive technology for imaging areas which are not visible to the human eye has become a bigger part of the diagnostic process. Dental radiology has played an exciting and critical diagnostic role in dentistry, never truer than now with the rapidly expanding array of imaging modalities. 2-D radiographs do not reveal the soft-tissue to hard-tissue relationships. Anatomical structures surrounding the teeth may superimpose causing anatomical or background noise, leading to difficulty in interpreting periapical radiographs; the superimposition of unwanted structures in 2-D imaging is the main problem is decision-making for correct diagnosis and treatment planning.1,2

3-dimensional craniofacial imaging is one of the most exciting and revolutionary topics in dentistry. The initial interest of CBCT focused primarily on applications in angiography in which soft-tissue resolution could be sacrificed in favor of high temporal and spatial-resolving capabilities. Since that time, several CBCT systems have been developed for use both in the interventional suite and for general and dentomaxillofacial applications.3

Diagnostic Applications of CBCT in Pediatric Dentistry:
Use of CBCT in pediatric patients should be justified in only those cases where conventional radiography fails to provide relevant information.

Pediatric dentomaxillofacial applications include:
- Airway Analysis
- Caries Diagnosis
- Interproximal Contacts
- Cleft Lip and Cleft Palate
- Craniofacial Morphology
- Development of Teeth
- Diagnosis of Hard Tissue lesion in the Oral Cavity
- Diagnosis of Impacted or Supernumerary teeth
- Diagnosis of Root Resorption and Root Fracture
- Diagnosis of Temporomandibular Joint disorder
- Endodontic Application

A) AIRWAY ANALYSIS
Upper airway cannot be accurately expressed by single linear measurements as performed on cephalograms. The TV(total volume) alone does not depict the morphology of the airway. A CBCT-based 3D analysis gives a better picture of the anatomical characteristics of the upper airways and therefore can lead to an improvement of the diagnosis.4,6

Fig 1: Total airway and the five parts (partial volumes) delimited by the six cross-sections (depicted in yellow). Cross-sectional areas on inclined plane and on horizontal plane.

B) CARIES DIAGNOSIS
Although using CBCT is not a routine method to detect primary caries, CBCT may be a valuable tool for detection of recurrent caries in certain clinical situations such as caries under FPD or buccal restorations. Careful evaluation of each single case may be recommended in order to avoid unnecessary radiation specially, when other lower-dose radiographic methods may give similar diagnostic data.7,8

Fig 2: Cross-sectional CBCT images A. amalgam restoration with recurrent caries. B. amalgam restoration with beam hardening artifact. C. amalgam restoration without recurrent caries. D.
C) INTERPROXIMAL CONTACTS

A threedimensional assessment and a classification of interproximal contacts might facilitate a complete understanding of the relationship of adjoining surfaces of teeth at different levels, namely the coronal, middle, and apical thirds. The contact areas vary as four different types, namely Open, X-shaped, I-shaped, and S-shaped; hence, we propose the OXIS classification of primary molars.9

<table>
<thead>
<tr>
<th>SN</th>
<th>Diagrammatic representation</th>
<th>Criteria</th>
<th>Type of contact</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.png" alt="Diagram of Open Contact" /></td>
<td>When there is no contact between the primary molars.</td>
<td>Open contact</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td><img src="image2.png" alt="Diagram of X-shaped Contact" /></td>
<td>When there is a point of contact (&lt;1.5 mm) between the primary molars.</td>
<td>X-shaped contact</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td><img src="image3.png" alt="Diagram of I-shaped Contact" /></td>
<td>When there is a straight contact (1.5-2.5 mm) between the primary molars.</td>
<td>I-shaped contact</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td><img src="image4.png" alt="Diagram of S-shaped Contact" /></td>
<td>When there is a straight contact (&gt;2.5 mm) between the primary molars.</td>
<td>S-shaped contact</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 3: Diagrammatic representation of the type of contact

Figure 4: CBCT images showing different types of contact areas between primary molars. (a) O type, (b) X type, (c) I type, and (d) S type.

D) CLEFT LIP AND CLEFT PALATE

The welfare of the patient is the prime objective for all involved in providing care to patient with Cleft lip and palate (CLP). It is a real 3D deformity of the face and A 3D imagery may be believed to include a greater understanding of the anatomical condition. Qualitative and quantitative information gained through research using CBCT should be incorporated into the cleft team to enhance the diagnosis and to refine the treatment plan.10-12

Figure 5: CBCT in the assessment of craniofacial structures in patients with CLP. (a) CBCT in the assessment of volume of cleft defect, (b) CBCT in the assessment of ABG, (c) CBCT in the assessment of ABT, (d) CBCT in the assessment of facial asymmetry in axial slice. CBCT: Cone-beam computed tomography, CLP: Cleft lip and palate, ABG: Alveolar bone grafting, ABT: Alveolar bone thickness.

E) CRANIOFACIAL MORPHOLOGY

CBCT craniometrical measurements are precise to a subvoxel scale and may potentially be used as a quantitative diagnostic method for orthodontics. Owing to variations in measurement precision between the two tests, two-dimensional cephalometric criteria cannot be readily used for three-dimensional measurements.13-16

F) DEVELOPMENT OF TEETH

Cone beam computed tomography (CBCT) has been used to evaluate the morphology of teeth. CBCT is a practical tool for noninvasive and three-dimensional (3D) reconstruction imaging by clinicians in dentistry applications and morphological analyses. Dent alveolar trauma to the primary teeth can lead to dislocation, dilacerations, discoloration, delayed eruption and
permanent teeth affected. The most common sequelae of such injuries are permanent teeth displacement and dilaceration. The severity of such condition depends on the force of impact, region of trauma and stage of tooth development of the permanent tooth.\textsuperscript{17,18}

G) DIAGNOSIS OF HARD TISSUE LESION IN THE ORAL CAVITY
The recent advent of cone-beam computed tomography (CBCT) can improve the quality of diagnosis and pre-operative hard tissue lesion assessment. Includes CBCT images of common benign neoplasms, cysts and other symptoms that affect the face and jaws. The value of an emerging jaw lesion for radiologist as well as a pediatric dentist if of prime concern to diagnose the lesion at an early stage, get a 3D view of that lesion with a CBCT and formulate a treatment plan accordingly.\textsuperscript{19-22}

H) DIAGNOSIS OF IMPACTED OR SUPERNUMERARY TEETH
The application of CBCT technique in pediatric dentistry can be helpful in detecting the exact position of supernumerary. CBCT imaging provides precise 3-dimensional representations of local dental and osseous structures, which is suitable for supernumerary teeth pretreatment assessment. Low-dose CBCT can be used for better assessment and localisation of supernumerary affected teeth prior to surgery.\textsuperscript{23-26}

Figure 8: (a) CBCT of a radicular cyst arising from a carious left mandibular molar presenting as a unilocular radiolucency extending down to the lower border of the mandible and displacing and eroding the lingual cortex (white arrows). (b) Sagittal and axial reconstructions of CBCT of a radicular cyst arising from a maxillary central incisor, which has been endodontically (root-filled) treated, presenting as a spherical unilocular radiolucency extending up to the floor of the nose and to the midline of the maxilla. (c) The panoramic reconstruction displays the cyst’s continuity with the oral surface of the palate (yellow arrow), whereas the sagittal reconstructions displays its continuity with the nasal surface.
I) DIAGNOSIS OF ROOT RESORPTION AND ROOT FRACTURE
Early diagnosis of root fracture and root resorption can reduce complications during treatment and the presence or absence of root resorption will determine the treatment plan. The severity of lateral incisor root resorption cannot be accurately judged from two-dimensional radiographs alone. CBCT has a smaller radiation dose compared to CT and overcomes the limitations of conventional radiography. Therefore, CBCT is a useful method for diagnosing the position, inclination, distance from adjacent structures, complications of impacted canines, and detection of lateral incisors root resorption.\textsuperscript{27,28}

J) DIAGNOSIS OF TEMPOROMANDIBULAR JOINT DISORDERS
A clinical examination alone is insufficient to fully assess the osseous and soft tissue component changes of the TMJ, and imaging is useful for the diagnosis process. Computed tomography (CT) and cone-beam computed tomography (CBCT) are often used to diagnose the defects of hard tissues of the TMJ. Compared with conventional image modalities and CT, CBCT has several advantages in detecting the bone changes of the TMJ, such as it provides three-dimensional images similar to CT but offers a relatively low radiation dose and high spatial resolution images for hard-tissue structures.\textsuperscript{29-32}

Fig 9: The 3-dimensional view (A) and the sagittal tomograph (B) show an inverted supernumerary tooth located completely within the nasopalatine duct.

Fig 10: Paraxial (A) and 3-dimensional (B) views show an inverted supernumerary tooth placed high at middle line of the anterior alveolar.

Fig 11: Image showing resorption to lateral incisor in the axial view.

Fig 12: CBCT image showing the measurement for length of the root in primary incisors.
K) ENDOdontIC APPLICATIONS

The detection of additional root canals requires a careful clinical and radiographic inspection. CBCT is a relatively new and effective technology, which provides an auxiliary imaging modality to supplement conventional radiography for assessing the variation in root canal morphology of primary teeth. The CBCT utility and significance to the act of endodontic is accounted for with expanding recurrence in the field of endodontics.33-35

Conclusion:

With the advent of the radio-technology called CBCT imaging, dentomaxillofacial radiology has taken a leap forward in its diagnostic capability. Visualization of anatomy and pathology has now replaced radiographic interpretation. Dentists and dental specialists now have an imaging modality that rivals that of their medical colleagues. Cone beam computed tomography (CBCT) is used for a wide variety of dental diagnostic uses, including in children and young people. CBCT typically has a radiation dose one or more orders of magnitude greater than that for conventional radiography. This is important in pediatric use because of the higher levels of risk associated with X-ray exposure in young age groups. This has stimulated efforts on justification and dose optimisation of CBCT in the paediatric context. No matter how exciting a new technology is, the dentist still has to look at its use in his or her practice as a business decision. Cone-beam will not replace intraoral or panoramic imaging techniques for dentistry entirely, but it is clear that the rapid adoption and better clinical decision-making data created by CBCT will ensure its continued use and continual adoption.

References:


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