"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]

Fig1: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 (right).

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]

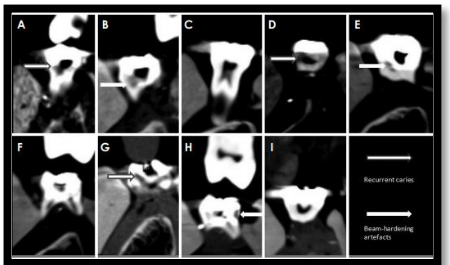
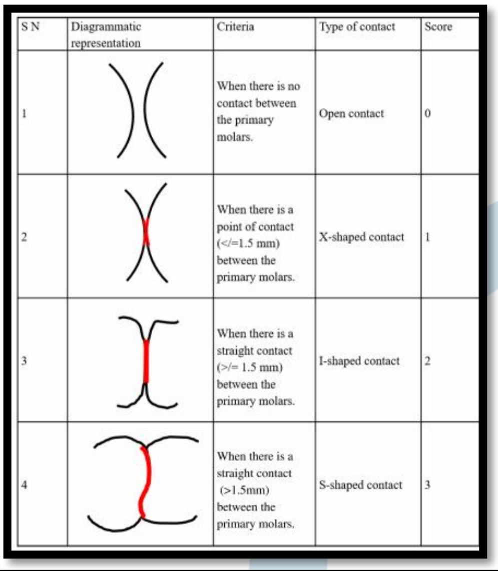


Fig 2:Cross-sectional CBCT images A. amalgam restoration with recurrent caries. B. amalgam restoration with beam hardening artifact. C. amalgam restoration without recurrent caries. D.

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]



S N	Diagrammatic representation	Criteria	Type of contact	Score
1		When there is no contact between the primary molars.	Open contact	0
2		When there is a point of contact (</=1.5 mm) between the primary molars.	X-shaped contact	1
3		When there is a straight contact (>/= 1.5 mm) between the primary molars.	I-shaped contact	2
4		When there is a straight contact (>1.5mm) between the primary molars.	S-shaped contact	3

Figure 3: Diagrammatic representation of the type of contact

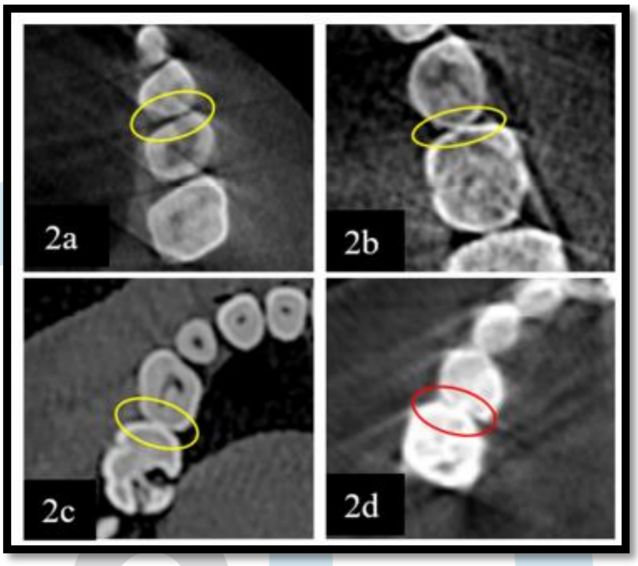


Figure 4: CBCT images showing different types of contact areas between primary molars. (a) O type, (b) X type, (c) I type, and (d) S type.

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]

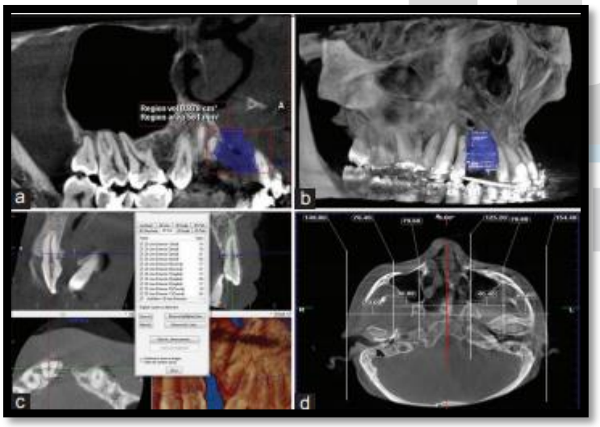


Figure 5: CBCT in the assessment of craniofacial structures in patients with CLP. (a) CBCT in the assessment of volume of cleft defect, (b) CBCT in the assessment of ABG, (c) CBCT in the assessment of ABT, (d) CBCT in the assessment of facial asymmetry in axial slice. CBCT: Cone-beam computed tomography, 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.[17,18]

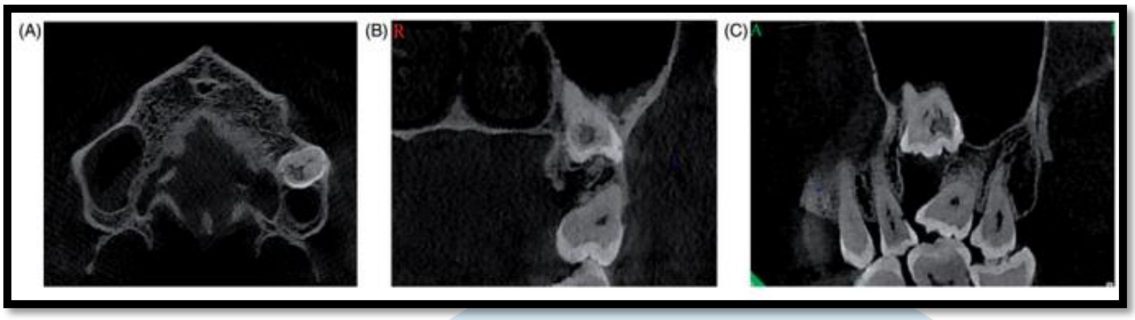


Fig 6: CBCT images; axial (A), coronal (B) and sagittal (C) of the unerupted teeth with pre-eruptive intracoronal resorption

G) <u>DIAGNOSIS OF HARD TISSUE LESION IN THE ORAL CAVITY</u>

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.[19-22]

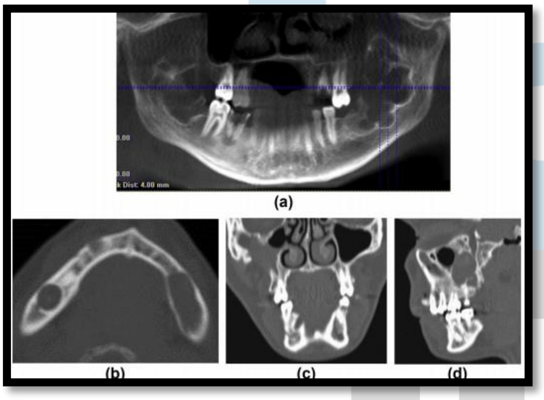


Fig 7: Panoramic reconstruction of CBCT of cherubism in a teenager. It displays lesions affecting the mandible and the left posterior maxilla. The most obvious lesions are the bilateral radiolucencies with corticated margins in the posterior sextants of the mandible. The lesion on the left is multilocular. The grossly carious right mandibular first molar also displays a periapical radiolucent lesion of inflammatory origin. (bed) Axial, coronal, and sagittal reconstructions of CBCT display multiple keratocysticodontogenictumours in a case of NBCCS.

H) <u>DIAGNOSIS OF IMPACTED OR SUPERNUMERARY TEETH</u>

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 used for better assessment and localisation of supernumerary affected teeth prior to surgery.[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.

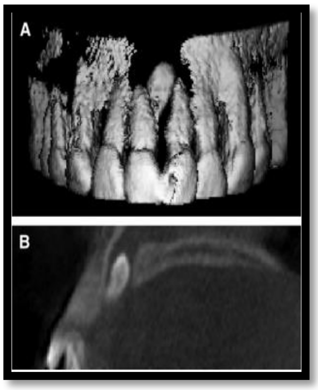


Fig 9: The 3-dimensional view (A) and the sagittal tomograph (B) show an inverted supernumerary tooth located completely within the nasopalatine duct.

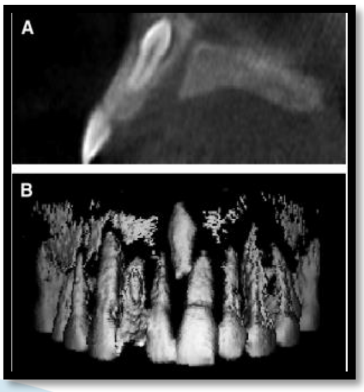


Fig 10: Paraxial (A) and 3-dimensional (B) views show an inverted supernumerary tooth placed high at middle line of the anterior alveolar

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.[27,28]

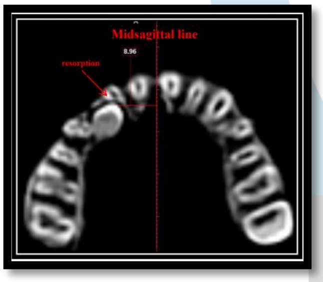


Fig 11: Image showing resorption to lateral incisor in the axial view.

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.[29-32]

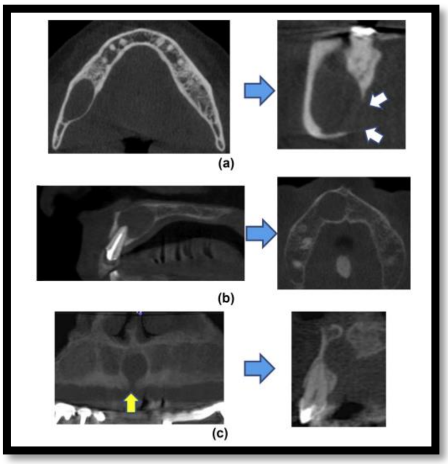


Fig 12: CBCT image showing the measurement for length of the root in primary incisors

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]

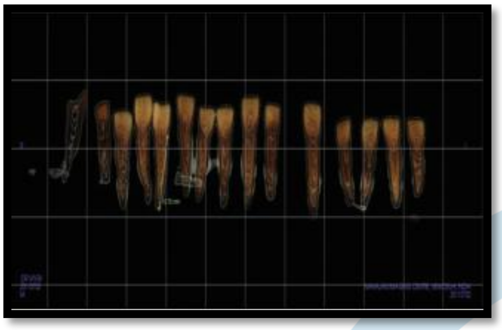


Fig13: The CBCT image showing the measure dimensions

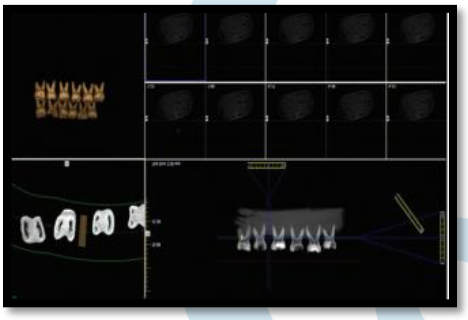


Fig 14: Cone beam computerized tomography image showing the measurement for diameter of root canals

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:
1) Shah N., et al. "Recent advances in imaging technologies in dentistry". World Journal of Radiology 6.10 (2014): 794-807.

2) Akarslan ZZ and Peker I. "Advances in Radiographic Techniques Used in Dentistry". Chapter 34 in: Mandeep Singh Virdi (Edition), Emerging Trends in Oral Health Sciences and Dentistry (2015).
3) Morton WJ. The x-ray and its application in dentistry. Dental Cosmos 1896;38:478-86.
4) Lenza MG, Lenza MD, Dalstra M, Melsen B, Cattaneo PM. An analysis of different approaches to the assessment of upper airway morphology: a CBCT study. Orthodontics & craniofacial research. 2010 May;13(2):96-105.
5) Alsufyani NA, Al-Saleh MA, Major PW. CBCT assessment of upper airway changes and treatment outcomes of obstructive sleep apnoea: a systematic review. Sleep and Breathing. 2013 Sep 1;17(3):911-23.
6) Zimmerman JN, Lee J, Pliska BT. Reliability of upper pharyngeal airway assessment using dental CBCT: a systematic review. European journal of orthodontics. 2017 Oct 1;39(5):489-96.
7) Salem WS, Awad MM, Almuhaizaa M. Role of CBCT in dental caries detection; a systematic review.
8) Kamburoğlu K, Sönmez G, Berktaş ZS, Kurt H, Özen D. Effects of various cone-beam computed tomography settings on the detection of recurrent caries under restorations in extracted primary teeth. Imaging science in dentistry. 2017 Jun 1;47(2):109-15.
9) Kirthiga M, Muthu MS, Kayalvizhi G and Krithika C. Proposed classification for interproximal contacts of primary molars using CBCT: a pilot study [version 2; referees: 2 approved]Wellcome Open Research 2018, 3:98 (doi: 10.12688/wellcomeopenres.14713.2).
10) Menezes LM, Azeredo F, Weissheimer A, Rizzato JL, Rizzatto SMD. Cone beam computed tomography evaluation of maxillary expansion in twins with cleft lip and palate. Dental Press J Orthod. 2012 Mar-Apr;17(2):42e.1-11.
11) Suomalainen A, Åberg T, Rautio J, Hurmerinta K. Cone beam computed tomography in the assessment of alveolar bone grafting in children with unilateral cleft lip and palate. European journal of orthodontics. 2014 Oct 1;36(5):603-11.
12) Parveen S, Husain A, Mascarenhas R, Reddy SG. Clinical utility of conebeam computed tomography in patients with cleft lip palate: Current perspectives and guidelines. J Cleft Lip Palate CraniofacAnomal 2018;5:74
13) Ludlow JB, Gubler M, Cevidanes L, Mol A. Precision of cephalometric landmark identification: cone-beam computed tomography vs conventional cephalometric views. American Journal of Orthodontics and DentofacialOrthopedics. 2009 Sep 1;136(3):312-e1.
14) de Oliveira AE, Cevidanes LH, Phillips C, Motta A, Burke B, Tyndall D. Observer reliability of three-dimensional cephalometric landmark identification on cone-beam computerized tomography. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Feb 1;107(2):256-65.
15) Chien PC, Parks ET, Eraso F, Hartsfield JK, Roberts WE, Ofner S. Comparison of reliability in anatomical landmark identification using two-dimensional digital cephalometrics and three-dimensional cone beam computed tomography in vivo. Dentomaxillofacial Radiology. 2009 Jul;38(5):262-73.
16) Gribel BF, Gribel MN, Frazão DC, McNamara Jr JA, Manzi FR. Accuracy and reliability of craniometric measurements on lateral cephalometry and 3D measurements on CBCT scans. The Angle Orthodontist. 2011 Jan;81(1):26-35.
17) Pokharel P, Nimbeni SB, Nimbeni BS, Rout SK. Displacement and Dilaceration of Permanent Teeth as a sequel of trauma to Primary Teeth diagnosed by CBCT: A Rare Case Report. Orthodontic Journal of Nepal. 2016;6(2):37-40.
18) Demirtas O, Dane A, Yildirim E. A comparison of the use of cone-beam computed tomography and panoramic radiography in the assessment of pre-eruptive intracoronalresorption. ActaOdontologicaScandinavica. 2016 Nov 16;74(8):636-41.
19) Yitschaky O, Redlich M, Abed Y, Faerman M, Casap N, Hiller N. Comparison of common hard tissue cephalometric measurements between computed tomography 3D reconstruction and conventional 2D cephalometric images. The Angle Orthodontist. 2011 Jan;81(1):11-6.
20) MacDonald D, Lesions of the jaws presenting as radiolucencies on cone-beam CT, Clinical Radiology (2016), http://dx.doi.org/10.1016/j.crad.2016.05.018
21) Vieira CL, Veloso SD, Lopes FF. Location of the course of the mandibular canal, anterior loop and accessory mental foramen through cone-beam computed tomography. Surgical and Radiologic Anatomy. 2018 Dec 1;40(12):1411-7.
22) Petcu A, Romanec C, Savin C, Prisacariu-Rados A, Dragomir B. THE IMPORTANCE OF CBCT EXAM IN DIAGOSIS AND TREATMENT OF DENTINGEROUS CYSTS AT THE CHILD. Romanian Journal of Oral Rehabilitation. 2018 Apr;10(2).
23) Liu DG, Zhang WL, Zhang ZY, Wu YT, Ma XC. Three-dimensional evaluations of supernumerary teeth using cone-beam computed tomography for 487 cases. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2007 Mar 1;103(3):403-11.
24) Nematolahi H, Abadi H, Mohammadzade Z, Ghadim MS. The use of cone beam computed tomography (CBCT) to determine supernumerary and impacted teeth position in pediatric patients: A case report. Journal of dental research, dental clinics, dental prospects. 2013;7(1):47.
25) Schubert M, Proff P, Kirschneck C. Improved eruption path quantification and treatment time prognosis in alignment of impacted maxillary canines using CBCT imaging. European journal of orthodontics. 2018 Nov 30;40(6):597-607.
26) Abdelgawad F, Wassef NM, AbdAlsamad A. Low-Dose CBCT for Localization of Impacted Supernumerary Teeth in Children. Egyptian Dental Journal. 2020 Jan 1;66(1-January (Orthodontics, Pediatric& Preventive Dentistry)):51-6.
27) Dudic A, Giannopoulou C, Leuzinger M, Kiliaridis S. Detection of apical root resorption after orthodontic treatment by using panoramic radiography and cone-beam computed tomography of super-high resolution. American Journal of Orthodontics and DentofacialOrthopedics. 2009 Apr 1;135(4):434-7.
28) Elhebieshy S, Morcos S, Ramadan A. Location of palatally impacted canine and its effect on root resorption using CBCT. Egyptian Orthodontic Journal. 2020 Dec 1;48(December 2015):85-96.

29) Çaglayan F, Tozoglu Ü. Incidental findings in the maxillofacial region detected by cone beam CT. Diagnostic and interventional radiology. 2012 Mar 1;18(2):159.
30) Cho BH, Jung YH. Osteoarthritic changes and condylar positioning of the temporomandibular joint in Korean children and adolescents. Imaging science in dentistry. 2012 Sep 1;42(3):169-74.
31) Illipronti-Filho E, FANTINI SM, Chilvarquer I. Evaluation of mandibular condyles in children with unilateral posterior crossbite. Brazilian oral research. 2015;29(1):1-7.
32) Ma RH, Yin S, Li G. The detection accuracy of cone beam CT for osseous defects of the temporomandibular joint: a systematic review and meta-analysis. Scientific reports. 2016 Oct 6;6:34714.
33) Joshi N, Deshpande A, Poonacha KS, Bargale S, Naik K, Mehta D. Cone Beam Computed Tomography Evaluation of Root Canal Anatomy in Primary Molars: An *in vitro* Study. Int J Clin Dent Res 2017;1(1):15-19.
34) Singh R, Chaudhary S, Manuja N, Chaitra TR, Sinha AA. Evaluation of different root canal obturation methods in primary teeth using cone beam computerized tomography. Journal of Clinical Pediatric Dentistry. 2015 Sep;39(5):462-9.
35) Gaurav V, Srivastava N, Rana V, Adlakha VK. A study of root canal morphology of human primary incisors and molars using cone beam computerized tomography: An in vitro study. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2013 Oct 1;31(4):254.