



## RESEARCH ARTICLE

### DIAGNOSIS MADE PRECISE AND PERFECT – CBCT IT'S APPLICATION IN DENTISTRY.

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#### Abstract

**Aim:** To summarise the application of CBCT in dentistry emphasising on its important in precise diagnosis.

**Background:** CBCT is the abbreviation for Cone Beam Computed Tomography. It is capable to project the dental imaging in three dimensions, which is better than the two dimensions radiographs. Generally, CBCT is a very useful tool for imaging the craniofacial region, by providing a detailed and sharp image under high resolution. The image produced can be used as a guidance for further diagnosis, treatment and even surgical procedures. In fact, CBCT also has low radiation exposure.

**Reasons:** To acknowledge the application of CBCT in of dentistry and its usefulness in diagnosis and treatment planning.

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#### Introduction:-

Generally, radiograph is the image produced on the radiographic film by the exposure of the X-ray radiations. There are lots of imaging techniques that are still available and used till now especially in dentistry, such as intraoral and extra-oral radiography, computed tomography and also tuned aperture computed tomography (TACT). Cone Beam Computed Tomography which is also known as CBCT is the advanced radiographs technology that enlightens the various field of dentistry, by giving a sharp three dimensional (3D) image.

CBCT creates a realistic and high resolution three dimensional image of the object on the oral and maxillofacial region, at a lower radiation dose [1]. The CBCT is also cheap and affordable when compared to conventional CT. Although its radiation dose is low when compare to other techniques, the radiation risk is almost similar to those intraoral radiographs, panoramic radiographs and also full mouth radiographic radiographs.

In addition, CBCT also provides a multiplanar image for the maxillofacial region and this process is known as multiplanar reformation (MPR), in which it produces image of a “real time” in axial plane as well as in two dimensional images in the coronal, sagittal, oblique and even in curved image planes [3]. In fact, CBCT also able to provide imaging in a single 360° rotation of a patient in a digital format, in relation to each rotation of the radiographic projection [4]. Then, the image is reconstructed by using an algorithm of volumetric tomography [5].

Hence, CBCT it is appropriate for the imaging of craniofacial area. Therefore, most of the dental practitioner tend to used CBCT, due to its various advantages in producing the radiographic image.

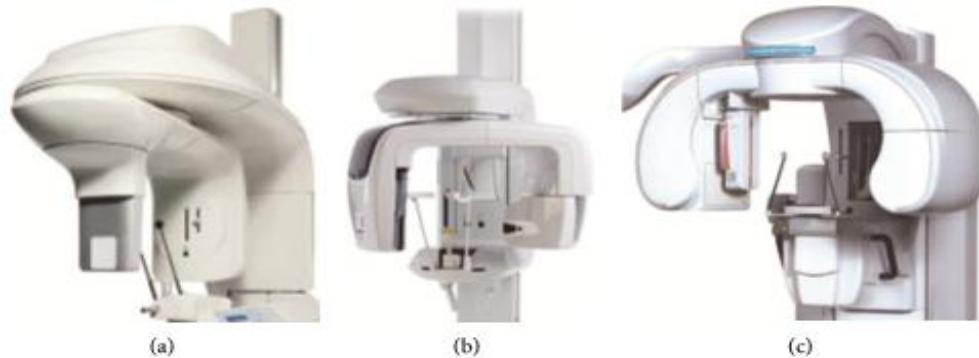
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**History:-**

Cone Beam Computed Tomography (CBCT) was established by the Japanese and Italian groups in late 1990s [6,7]. They were working independently in developing this new tomographic scanner which is also known as digital volume tomography (DVT), for specific function on maxillofacial and dental only.

In 2001, the first dental CBCT radiograph had become commercially accessible for the dentomaxillofacial imaging [5]. This was the beginning for the commercialized use of the CBCT. It had gained lots of attention from people especially from the dental practitioner, due to its various advantages like low dose, detailed image and also low cost. Along with its various functions in dentistry such as caries diagnosis, implantation, periodontal bone characterization and also its application in endodontics.



**Figure 1:-** Examples of hybrid CBCT. (a) KODAK Dental Imaging 9000 3D, (b) Veraviewepocs 3D, and (c) Picasso Trio [3].

**Advantages of CBCT:****Limitations of X-ray Beam:**

CBCT can be adjusted to scan small regions. This can be done by reducing the size of irradiated area by collimation of the primary X-ray beam to a particular area along with reducing the dose of the radiation [3].

**Image Accuracy:**

Voxels which is a 3D block of smaller cuboid structures is a volumetric data that display the degree of the X-ray absorption, and its size help in determining the resolution of the image. All CBCT systems have isotropic voxels resolutions, which mean it is equal for all of the three dimensions. Thus, this will result to formation of the sub-millimetre resolution from 0.125 mm to 0.4 mm [3].

**Shorten Time of Scanning:**

CBCT can be done in a single 360° rotation of a patient, in a short period of 10 to 70 seconds, to produce image [3].

**Lower Dose:**

The radiation dose used in CBCT is very low compare to conventional fan-beam CT up to 98%. This will result to decreased of the effective radiation dose to almost 4-15 times of a single panoramic radiograph [3].

**Decreased the Image Artifact:**

Through manufacturers artifact suppression algorithms, the CBCT will display the image on a low level of metal artifact, specifically in designed for the secondary reconstructions for observing the teeth and jaws of the patient [9].

**Applications of CBCT:****Caries Diagnosis ( General Dentistry):**

In general dentistry, CBCT imaging is very beneficial for assessing the detection of the caries and its depth in the approximal and occlusal lesions [1].

### Endodontic Applications:

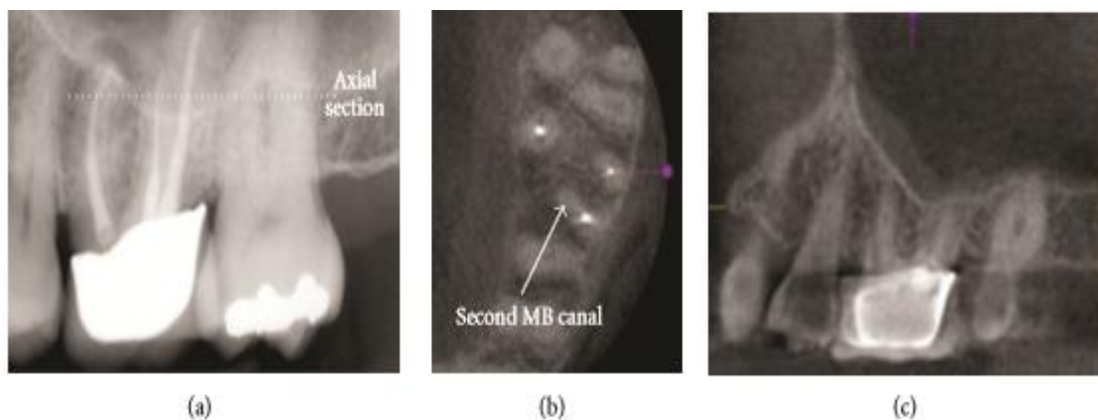
CBCT play a significant role in the endodontic applications because it provide a three dimensional image of the anatomical features of the structures inside of the mouth, that cannot be produced either by intraoral or panoramic radiographs. The CBCT is commonly used for diagnosis of the peri-apical lesions due to the pulpal inflammation, visualization of canals, clarification of internal and external resorption, and also recognition of root fracture [1].

Following are the beneficial used of CBCT in endodontic applications:

### Assessment Of Tooth Morphology:

All root canals can be demonstrated in three dimensional image by the CBCT technique. Through this, the root canals can be accessed, cleaned, shaped and also obturated [10].

The CBCT able to identify the second mesiobuccal canal (MB2) in maxillary first and second molars [12]. The accuracy of the identifications of the MB2 is differs, based on the investigation method used in a range of 69% to 93% accuracy [10]. On top of that, CBCT images also showed the existence of untreated or missed canals intraoperatively or in root filled teeth, including its complications [11].



**Figure 2:-** In (a) a periapical lesion can be seen through the periapical radiograph. The CBCT imaging accurately displayed the previous additional canal that was not treated (b) 0.076mm and (c) 0.076 parasagittal [3].

### Detection of Apical Periodontitis:

CBCT can identified the radiolucent finding beforehand. The peri-apical radiolucency is detected first before it is displayed on the conventional radiographs [11]. CBCT can detect any bone defect in the cancellous bone and cortical bone separately [11], although they cannot be detected conventional radiographically especially in the cancellous bone [13]. Thus, this shows that CBCT has high potential in detection of radiolucencis in apical periodontitis when compare to peri-apical radiography [14].

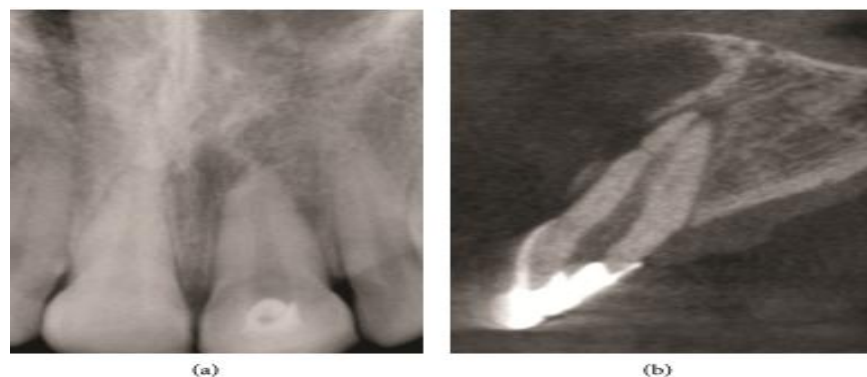
### Pre-surgical Assessment:

CBCT has a significant role in detection for palatal roots of maxillary first molars in planning for its peri-apical microsurgery [15]. The measurement of the gap between the cortical plate and apex of palatal roots can be established by the CBCT as well as the existence or absence of the maxillary air sinus in between the roots of the maxillary first molars. Thus, the thickness of the cortical plate, fenestration, pattern of the cancellous bone and also inclination of teeth's roots can be determined preoperatively by using CBCT for surgery planning [16].

### Traumatic Injuries and Sequelae Assessments:-

#### Assessments of Root Fractures:

The fractures of the crown is more common compare to the fractures of the roots, and it occur about 7% or lesser in dental injuries [17, 18]. CBCT can assessing the vertical roots fractures under the influence of the root canal filling. Potentially, it demonstrated a highly accurate image compare to periapical radiographs [19]. In fact, CBCT also can be used to detect the horizontal root fractures as we can see in figure 3 (b). This capability of CBCT has been reported and approved by the Kamburoğlu et al [20]. Hence, CBCT is an accurate technique that can be used to diagnose any root fractures.



**Figure 3:-** Horizontal root fracture on the anterior dentition due to traumatic injuries. (a) Image produced by using peripical radiographs and (b) image established using CBCT [3].

#### **Assessments of Roots Resorption:**

CBCT is an excellent system for assessment of the root resorption. It has been successfully used for the determining and confirmation of the internal root resorption (IRR) and differentiate it from the external root resorption (ERR) [21].

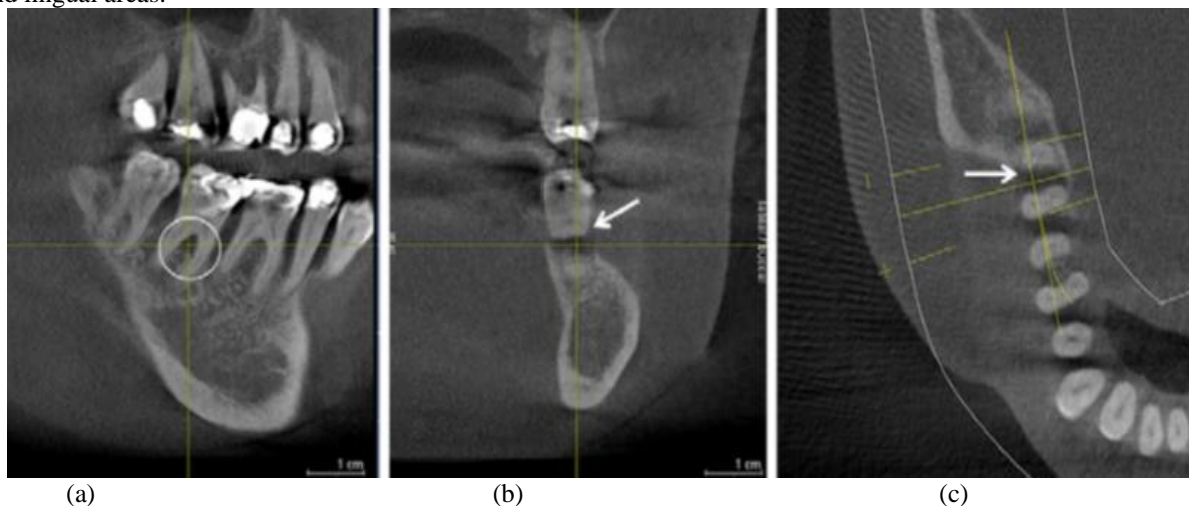
#### **Assessments of Post-operative:**

CBCT is used to monitor the success of the healing of the peri-apical lesions [10].

#### **Periodontal Applications:-**

In periodontal, CBCT help in displaying the image of the periodontal bone in an accurate description. Researchers Vandenberghe and colleagues [22] studied on the structure of the periodontal bone by using the 2-dimensions CCD and also full volume of the 3-dimensions CBCT000- based imaging modalities [1,22]. From their investigation, they found that the measurements of periodontal bone levels and defects of CBCT image were comparable to the intraoral radiographs. In fact, they also concluded that CBCT images have high capability in displaying the morphologic description of periodontal bone [1].

In a research conducted by Misch and team-mates [23], they found a similar result about CBCT as in the study of Vandenberghe. However, in their research they found a significant characteristics of image produced by the CBCT, in which the image produced by the CBCT is precise and similar to the used of periodontal probe in measuring the bony defects. This is along with providing a detailed morphologic description of the architecture of the bone [23, 24]. It also can be used for imaging the interproximal regions and also for the measurements of defects on buccal and lingual areas.



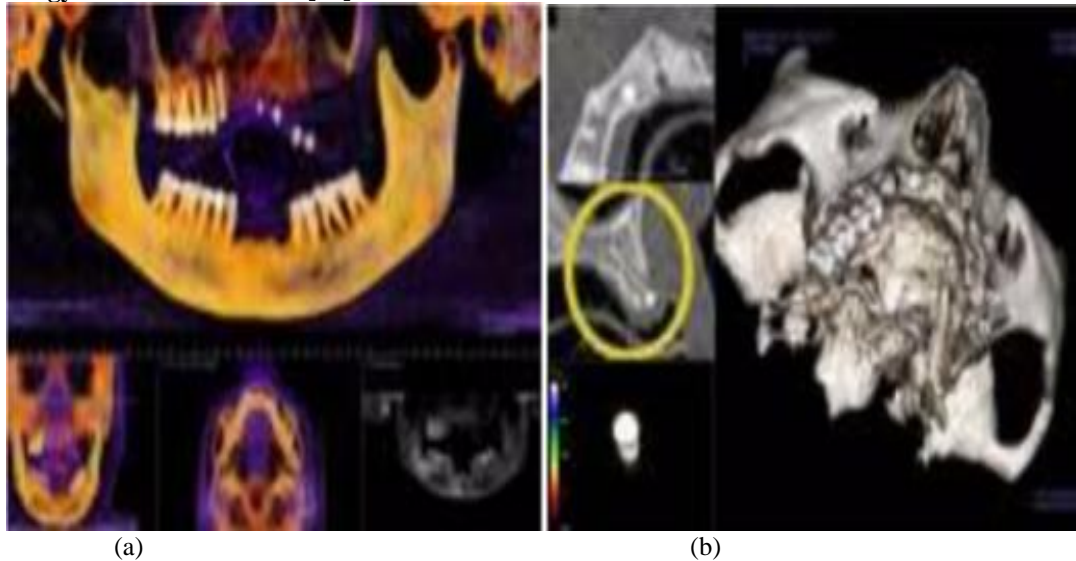
**Figure 4:-** The (a), (b) and (c) image demonstrated a complete periodontal furcation of second molar. (a) A furcation is highlight by the circle. (b) and (c) The arrow on the images show the extent of lesion from facial-lingual and axial views [1].

In an article of digital volume tomography (DVT) for diagnosis in periodontology written by Kasaj and Willershausen [25], they concluded that CBCT is a perfect techniques for periodontal application. Especially in the intrabony defects, dehiscence and fenestration defects regions, periodontal cysts as well as for the diagnosis of the furcation that involved molars teeth. This is due to its lower radiation dose and production of high resolution image [1,25].

#### **Applications in Oral Maxillofacial Surgery:**

CBCT helps to display the jaw pathology, pre and post surgical evaluation of fractures, impacted and super numerary teeth, assessment of bone graft, paranasal sinuses and etc [24] in a three-dimensional image that is important for oral maxillofacial surgery.

#### **Implantology and Prosthodontics [26]:**



**Figure 5:-** (a) The images displayed on the faulty implant planning. (b) The images shown on the implant planning [24].

CBCT is used for evaluation of the site of implant, accurate measurements and planning of implant that corresponds to vital structures, surgical guide and also for computerized prosthesis for any developmental disturbances [24].

#### **Plastic Surgery [27]:**

CBCT is used for estimation of the dental age and three-dimensional face reconstruction. It is useful for evaluating any ENT problems like DNS , paranasal sinuses, syndromes, pre and post evaluation after the plastic surgery [24].

#### **Orthodontics applications:**

The CBCT images can also be used in orthodontic assessment.

#### **Conclusion:-**

CBCT is an effective diagnostic aid in all field of dentistry. The advantages of CBCT outweigh the disadvantages. In fact, it is better compared to other radiographs in many aspects, like producing high resolution and sharp images, low dose of radiation and can be used widely in many areas as it able to demonstrate accurate and detailed image on the particular areas. In addition, the CBCT also available as a low cost technique.



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