

## **CONE BEAM COMPUTERIZED TOMOGRAPHY (CBCT) IN CLINICAL PRACTICE**

The introduction of Cone Beam Computerized Tomography (CBCT), sometimes referred to as Cone Beam Volumetric Imaging (CBVI) or Cone Beam Volumetric tomography (CBVT), has revolutionised the dental profession's ability to gather, process and apply patient images for diagnostic and treatment planning purposes

These machines' image acquisition process differs from that of traditional medical computerized tomography (CT) in that:

the patient is not usually supine

the image gathered is in a voxel (volume element) format

the x-ray dose absorbed by the patient is substantially lower (up to 80% less for comparable images)

it is less expensive

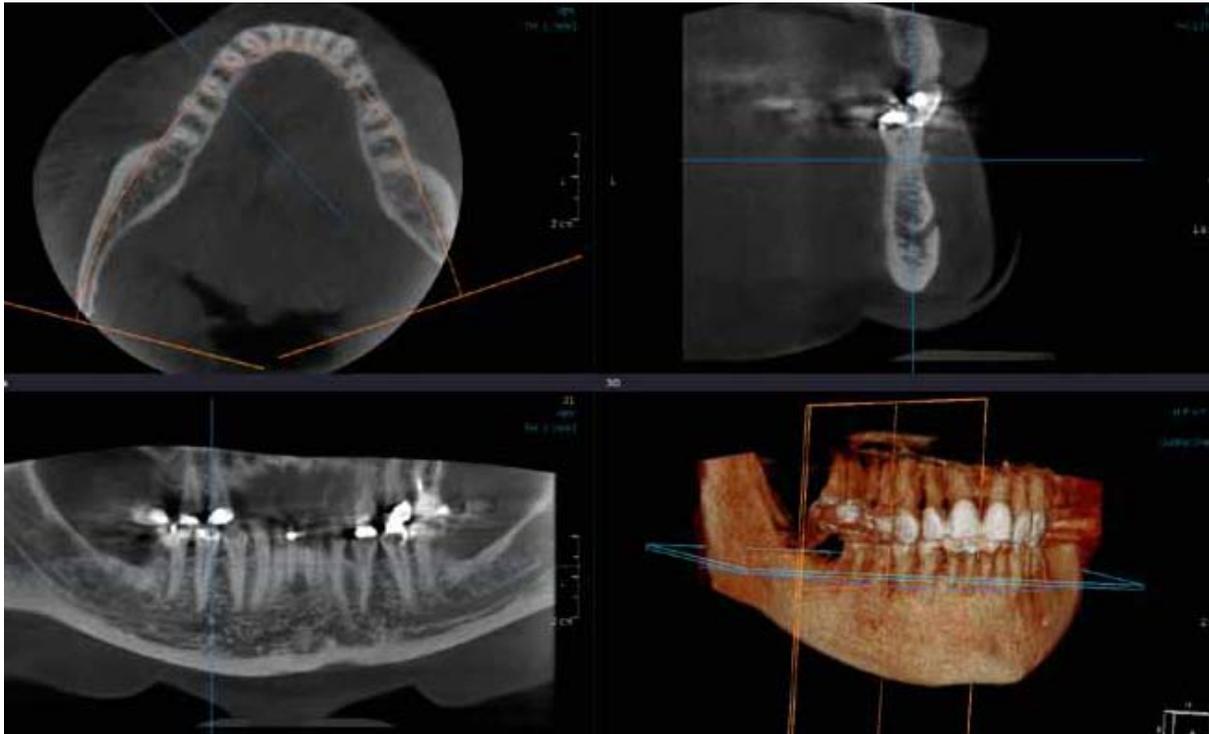
although CBCT produces significant data volumes like medical CT it is vastly superior to traditional CT data for specific dental and ENT applications

CBCT in conjunction with its associated software makes clinical decision making easier and more precise, patient treatment decisions more accurate and visualisation of the x-ray data more meaningful. In the 21<sup>st</sup> century dentistry is moving away from 'radiographic interpretation' into 'disease visualization' and CBCT could not have come at a better time

It is predicted that by 2013 the reconstructed data in 2D/3D grayscale and colour formats from CBCT machines will become the standard of care for displaying patients' radiographic information in cases of pre-operative implant site assessment, implant placement and follow-up radiographic assessment and that other imaging modalities will probably become obsolete in these implant applications

Additional applications are listed below (box) and will undoubtedly be added to as clinicians become more familiar with the benefits this imaging modality provides in diagnosis, decision making and treatment planning

<b>Applications of CBCT</b>
3-D virtual model construction and computer-aided design
Fabrication of computer-aided surgical implant guides
Production of sterile sinterized skull models for block bone graft adaptation prior to flap-raising
Airway studies related to sleep apnoea
3 <sup>rd</sup> molar impaction assessment
Impaction related to orthodontics
Inferior alveolar nerve location for implant placement and 3 <sup>rd</sup> molar extraction
Odontogenic lesion visualisation
Orthodontic assessment
Paranasal sinus evaluation
Space analysis (1:1)
TMJ visualisation
Trauma evaluation



### The data volume vs the single image

investigation	image size	No of images in a 800MB CD-ROM
Digital periapical view	~300kB	~2400
Digital panoramic image	5-7MB	>100
CBCT data volume	100-250MB	3-8

The impact of this data volume is huge – in terms of storage and accessibility as well as in the context of clinical responsibility. As a clinician, the dentist ordering or acquiring a CBCT data volume for his/her patient is responsible for *all* of the information in it. After more than 100 years serving as our own radiology experts, we are obliged to shift responsibility for the overall image findings to a qualified radiologist to look at our patients' data for pathology that may not be familiar to us in anatomic regions and perspectives that may be equally unfamiliar

The amount of data needed varies according to the diagnostic task in hand. Currently, orthodontic assessment usually involves intra-oral, panoramic and cephalometric views as well as plaster study casts. CBCT imaging is able to provide all of these views, even in their traditional form as well as 3D (sinterised) models – so the ability to acquire all the diagnostic aids in one single imaging procedure

offers orthodontists a very distinct advantage over current methods. Having said this, we should be aiming at making *practising by applying selection criteria* our standard *modus operandi*

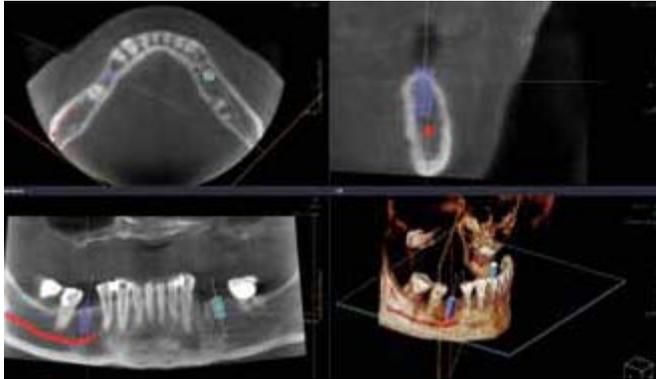
The smallest volume required for the task in hand is the one that should be requested – for evaluating a single impacted third molar the smallest available field-of-view should suffice and this obviates the need to sift through as many as 512 slices in an extra-large FOV that covers the entire skull. In the same way, the reconstruction of a panoramic view from an XL FOV requires anywhere from 4 to 70 times the x-ray dose needed for a traditional OPG or periapical view. Therefore a traditional 2D view from a standard machine can often suffice for the preliminary evaluation of a patient's dentition, bone, TMJ and related anatomy.



### Radiation Dose

X-ray imaging is a compromise between image quality and x-ray dose. In CBCT machines this dilemma has been resolved by combining high image quality with low dose. The key factors in achieving this are pulsed x-ray generation, selectable imaging modes and the innovative Algebraic Reconstruction Technique (ART) image reconstruction method. ART needs a lower dose than conventional algorithms. And further, because the system is less sensitive to patient movement and metal artefacts, the image quality is consistent and the success rate is very high, minimizing retakes. The x-ray dose in all the fields of view is low. The minimum effective dose can be compared to one digital panoramic exposure and, at maximum, to a few panoramic exposures in a larger field of view and higher resolution. Although the radiation dose from CBCT machines is significant, it is much less than that of conventional medical CT scans. Ludlow et al reported that for a procedure such as an implant site assessment, the absorbed x-ray dose from a CBCT examination was between 1 and 25% of the dose absorbed from a medical CT scan. This makes the latter unjustifiable for dental applications.

With CBCT, the advanced dental imaging required for diagnostics, implant treatment planning and oral surgery can now be done in the practice setting. More advanced procedures can be performed efficiently and safely. Diagnostic information can be obtained without delay and with fewer referrals to outside facilities for procedures such as medical CT examinations. The whole treatment planning process, from the first contact through radiological examinations, case planning, treatment acceptance, and follow-up, can be handled in one practice.



3D imaging allows the dentist to improve patient care by enhancing diagnostic accuracy and performance as well as planning and implementing the best alternatives. Through DICOM support, CBCT systems integrate with other imaging software and modalities and are compatible with most specialty third party software, drill and surgical guide applications.

## References

1. Miles DA. Clinical experience with cone beam volumetric imaging. *US Dent* 2006; Sep: 39-42
2. Ludlow JB, Davies-Ludlow LE, Brooks SL. Dosimetry of two extra-oral imaging devices. *Dentomaxillofac Radiol* 2003; 32:229-234
3. Danforth RA, Miles DA. CBVI: 3D applications for Dentistry. *Ir Dent* 2007; 10(9):14-18
4. Soredex Scanora 3D brochure 2010: 18-19