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"Monday Morning Pearls of Practice by Bobby Baig"

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Fundamentals and Guidelines for CBCT Imaging: Part 1

Introduction:

CBCT has revolutionized diagnostic imaging in dentistry. Unlike conventional intraoral, panoramic and cephalometric radiographs which provide 2-D images, CBCT provides volumetric imaging with the ability to visualize the imaged region in virtually any plane. CBCT uses ionizing radiation and thus carries a risk of radiation-induced cancer. It is important that dental professionals develop guidelines and recommendations for its proper use. Although the modalities of imaging have advanced, the basic principles of interpretation of the radiographic examinations remain the same. One such principle is that the radiographic examination must be evaluated over the entire region imaged and not limited to only the region of immediate diagnostic interest. The upper airway is often encompassed during CBCT imaging. Incidental airway abnormalities are detected on CBCT scans in 21 percent to 52 percent of patients. The airway abnormalities may increase suspicion of obstructive sleep apnea and such patients would benefit from appropriate referral to specialists in sleep medicine.

CBCT Indications:

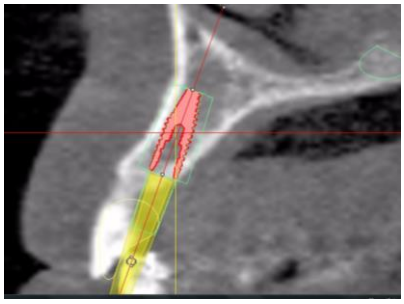
CBCT imaging has applications in most aspects of dental practice, including:

A. Endodontics.
B. Implant treatment planning.
C. Intraosseous jaw bone pathology.
D. Impacted teeth.
E. Craniofacial assessment for orthodontic and orthognathic surgical diagnosis and treatment planning.
F. Evaluation of TMJ.
G. Dentomaxiliofacial trauma.
H. Paranasal diseases, ENT.

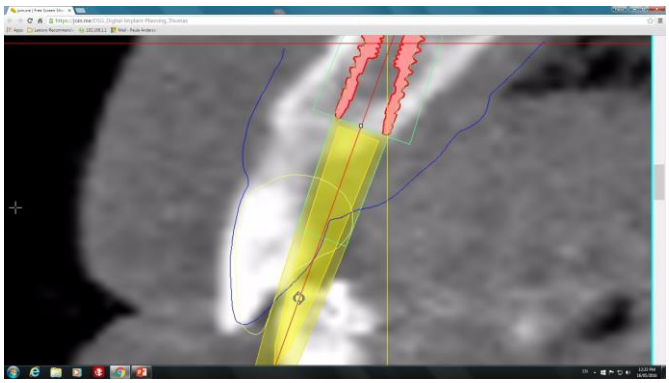
Advantages of CBCT: Virtual Planning

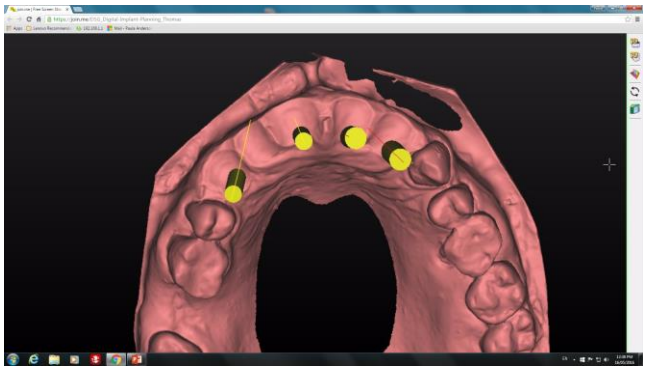
1. Several commercially available software programs use the DIACOM data from CBCT scans to facilitate diagnosis and treatment plan.

2. These software packages allow
   A. Virtual placement of implants.
   B. Stimulation of orthognathic surgery.
   C. Preparation of stereolithic graphic models, fabrication of surgical guides for implant placement.
   D. Superimposition of 3D photographs.
   E. Optically scanned study models.



A. Virtual implant placement. C: Stereolithic graphic models. C: Surgical guides.





D. Superimposition of 3D photographs and Diacom data. E. Optically scanned study models.

Efficacy of Diagnostic Imaging Modality:

1. The use of any ionizing radiation based imaging modality is associated with a risk of radiation induced cancer.
2. The basic premise that justifies the use of these imaging modalities is that the benefits provided by the radiographic examination must far outweigh the risk associated with radiation exposure.
3. In the era of increasing health expenses, it is also important to justify the higher costs with CBCT.
4. The impact of enhanced diagnosis on decision making and therapeutic outcome must be considered in the choice of the most appropriate imaging modality.
5. The optically scanned study model model clinicians with an excellent framework of the various considerations when ordering diagnostic imaging for their patients.

<u>Thombury and Fryback et al:</u>

Proposed a six-tier hierarchical model to evaluate applications of new technologies for diagnostic imaging. The six levels are to address technical efficacy, diagnostic accuracy, diagnostic thinking, therapeutic efficacy and

patient outcome. (Table 1)

TABLE

Fryback and Thornbury's Hierarchical Model to Evaluate the Efficacy of a Diagnostic Imaging Modality

Level	Description	Examples of Measured Parameters
Level 1: Technical efficacy	Technical parameters of image quality.	Spatial resolution, contrast resolution.
Level: Diagnostic accuracy	How well does the test predict presence/absence of disease?	Sensitivity, specificity, positive and negative predictive values.
Level 3: Diagnostic thinking efficacy	Does the diagnostic test impact the clinician's diagnostic thinking?	Was the diagnosis changed? Was the prognosis altered?
Level 4: Therapeutic efficacy	Does the diagnostic test change the clinician's treatment choice?	Was there a change in the treatment plan?
Level 5: Patient outcome efficacy	Did the test impact the patient's treatment outcome?	Was the response to therapy different? Did it impact quality of life?
Level 6: Societal efficacy	Does test implementation impact societal costs?	Cost-benefit analysis.

CBCT Technical Parameters:

X ray exposure parameters:

1. Ideally the tube voltage and tube current should be adjusted for every patient.
2. In some models this is fixed and cannot be changed by the operator.
3. It is important to remember the balance between radiation dose and image quality. Dose reduction procedures must not compromise the diagnostic quality of the CBCT scan.

Field of View (FOV):

1. The FOV is an important parameter that defines the CBCT imaging protocol.

2. FOV is described as;
   A. SMALL: (Less than 8cm)
   B. MEDIUM: (8 to 15cm)
   C. LARGE: (Greater than 15cm)

3. Adjusting the FOV impacts the following:
   A. Anatomic coverage.
   B. Image resolution.
   C. Patient radiation dose.

4. Smaller FOV Advantages:
   A. Higher spatial resolution,
   B. Reduced scattered radiation
   C. Improved image quality
   D. Less radiation dose.

Voxel Size:

1. In a 2-D image resolution data is measured in Pixel and for the 3-D image the unit of measurement is Voxel.
2. This represents the smallest 3-D data unit on a CBCT scan.

3. In the newer systems, the voxel size varies from 0.076mm to 0.4mm.
4. In some units, the voxel is fixed for a specific FOV.

Number of Basis Projections in CBCT:

1. The x-ray tube and the receptor acquire multiple projections.
2. Higher number of projections yields an image with higher spatial resolution and greater contrast resolution.
3. Quick Scan Mode: An approach to decrease the scan time and radiation dose and to acquire fewer basis projections. Example; Root parallelism during orthodontic treatment. This might not benefit the assessment of other tasks like PDL space, small areas of root resorption.
4. Higher Resolution Mode: In this mode, the basis projections, higher radiation dose is increased. In this mode, the scan time is longer, but this does not necessarily provide additional value.
5. Rotational Arc: (180 degree versus 360 degree scans), some CT scan machines have partial rotation of 180 degree instead of 360 degrees. In some units, the rotation is only 180 degrees, this will provide fewer basis projections. The advantages are reduced scan time and patient exposure. Image quality is lower but does not compromise the diagnostic quality.

Summary:

The FOV, number of basis projections and voxel size used will impact the image quality and the patient radiation dose. Clinicians who operate their own unit must be familiar with the features of their individual units, specifically the diagnostic quality and the radiation dose delivered by the various protocols on their units.

Continued in next editions; Diagnostic value of CBCT imaging beyond the dentoalveolar region, guidelines for usage in endodontics, Orthodontics and implant dentistry…….

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