PRACTICE PAPER

Cone Beam Computed Tomography and Dental Implications

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ABSTRACT

CBCT imaging provides sub-milimeter spatial resolution images of high diagnostic quality with relatively short scanning of 10-70 sec and a reported radiation dose equivalent to that needed for 4-5 OPG, i.e upto 15 times lower than conventional CT scan.

Keywords: x-Ray computed /methods, dental tomography

INTRODUCTION

Cone Beam Computed Tomography (CBCT) provides multiplanar imaging compared to thin slice images produced in the axial plane by the conventional helical fan beam computed tomography. CBCT creates real time images not only in axial plane but also 2 dimensional images in coronal,sagittal and even oblique or curved image planes called as multiplanar reformation (MPR).In addition CBCT data is amenable to reformation in a volume i.e in three dimensions.[1]

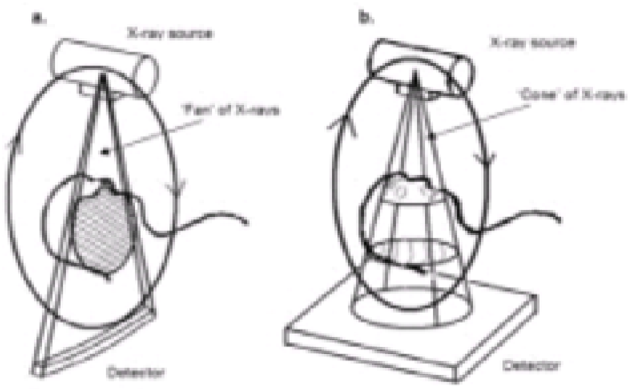
Computed tomography can be categorized based on geometry of X-Ray beam as fan beam and cone beam tomography

Fan beam tomography

X-Ray source and detector are mounted on a rotating gantry. Data are acquired using a narrow fan shaped X-Ray beam transmitted through the patient .The patient is imaged slice by slice, in axial plane and interpretation of images done by stacking slices to obtain multiple two dimension representation. The multidetector array is used, which allows multidetector CT(MDCT) scanners to acquire nearly 64 slices simultaneously,considerably reducing the scanning time compared with single slice systems and allowing generation of 3D images at substantially lower doses of radiation than single detector fan beam CT arrays.[2,3]

Cone beam tomography

Cone beam is based on volumetric tomography,which uses 2D extended digital array providing an area detector .It is combined with a 3D X-Ray beam.Cone beam technique involves asingle 360^0 scan in which X-Ray source and reciprocating area detector synchronously move around the patient head,stabilized with a head holder.At certain degree intervals ,single projection images, known as ‘basis images’ are acquired.These images are similar to lateral cephalometric images ,each image slightly offset from another.This series of basis projection images is referred to as projection data.Software programs are applied to the image data to generate a 3D volumetric data, which can be used for primary reconstruction images in three orthogonal planes (axial, sagiittal, coronal)[3,4]



Dental implications

-CBCT allows dentists 3D diagnosis

-3D scans yield accurate assessment:3D orthodontic CBCT scan useful in breathing and airway analysis(sleep disorders) which prior to CBCT was possible only with a full cranial CAT scan.

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Advantages of CBCT

1. *Image clarity*: Clear images of highly contrasted structures is useful for evaluating bone[4,5]
2. *Decreased radiation dose*: Minimizes radiation dose by decreasing size of irradiated area by collimation of primary x-ray beam .Most CBCT units can be adjusted to scan small regions for specific diagnostic tasks.[6,7,8]
3. *Image accuracy*: Volumetric data comprises a 3D block of smaller cuboidal structure,known as voxels,each representing a specific degree of X-Ray absorption. The size of these voxels determines resolution of images. All CBCT units provide voxel resolutions that are equal in all three dimensions.This provides sub-milimeter resolution ranging from 0.4-0.125 mm.[9,10]
4. *Rapid scan time*: CBCT acquires images in a single rotation,with rapid scan time of 10-70 sec.[11,12]
5. *Dose reduction*: The dose is reduced upto 98% compared to conventional fan beam CTsystems i.e effective patient dose to approximately that of film based periapical survey of dentition (13-100 micro sev) or 4-15 times that of a single panoramic radiograph (2.9-11 micro sev).[13]

CBCT sensor contains image intensifier and a CCD camera, or an amorphous silicon flat panel detector. The single turn motion image –capture used in cone beam tomography is quicker than traditional spiral motion,and can be accomplished at a lower radiation dose as a result of no overlap of slices.This resulting in greater image clarity. This type of imaging exposes a patient to less radiation than traditional CT scanners. Manufacturers are designing CB scanners with the physical space available in clinics and the patients comfort in mind,for example upright seating is used in CBCT scanners with the X-Ray tube and the panel detector rotating around the patients head.

CB volumetric imaging is a recent and fast growing addition to the dental industry.The number of options for CB scanners more than the quadrupled termed as ‘ultra cone beam CT scanners’. Amorphous silicon panel detectors, found in CBCT scanners reduce optical distortion.The images from flat panels are much sharper and dimensionally accurate for correct measurements. The dimensions of sensor(pixel) vary with the machine.

Disadvantage

Conventional radiographs better than CBCT to assess periodontal ligament space.

CONCLUSION

CBCT technique presents an innovation of tomographic imaging systems and subsequent volumetric image reconstruction for dentistry. CBCT is characterized by rapid volumetric image acquisition from a single low radiation dose scan of the patient.

REFERENCES

1 William CS, Allan GF, Predag S. Cone beam CT in dental radiology J Can Dent Assoc 2006;72(I):75-80

2 Hu H, He HD, Foley WD, Fox SH. Four multidetector row helical CT: Image quality& volume coverage speed. J Radiology 2000;215(I):55-62

3 Sukovic P. Cone beam CT in craniofacial imaging .J Orth Craniofac Res 2003;6(suppl 1):31-6

4 Ziegler CM, Woertche R, Brief J, Hassfeld S. Clinical indications for digital volume tomography in oral & maxillofacial surgery. Dentomaxillofac Radiol 2002;31(2):126-30

5 Cohen M, Kemper J, Mobes O, Pawelzik J, Modder U.Radiation dose in dental radiology.Eur Radiol 2002;12(3);634-7

6 Schulze D, Heiland M, Thurmann H, Adam G. Radiation exposure during midfacial imaging using 4 & 16 slice computed tomography. cone beam CT systems & conventional radiography. Dentomaxillofac Radiol 2004;33(2):83-6.

7 Ludlow JB, Davies LE, Brooks SL. Dosimetry of two extraoral direct digital imaging devices. Newtom cone beam CT & orthophos plus DS panoramic unit. J Dentomaxillofac Radiol 2003;32(4)229-34.

8 Scaf G, L urie AG, Mosier KM. Dosimetry & cost of imaging osseointegrated implants with film based & CT. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1997;83(1):41-8.

9 Dula K, Mini K, Vander PF. Hypothetical mortality risk associated with spiral CT of the maxilla & mandible Eur J Oral Sciences 1996;104(5-6);503-10.

10 Ngan DC, Kharbanda OP, Geenty JP, Darendelier MA: Comparision of radiation levels from CT & conventional dental radiography. Aust Orthod J 2003; 19(2):67-75.

11 White SC: Assessment of radiation risk from dental radiography; Dentomaxillofac Radiol 1992; 21(3):118-26.

12 Danforth RA, Clark DE: Effective dose from radiation absorbed during a panoramic examination with a new generation machine: Oral Surg Oral Medi Oral Pathol 2000;89(2):236-43.

13 Gibbs SJ : Effective dose equivalent and effective dose comparision for common projections in Oral & Maxillofacial radiology. Oral Surg Oral Med Oral Pathol 2000;90(4):538-45.