FACULTYPERSPECTIVE

VIEWS ON DENTAL TOPICS & TRENDS

Cone Beam Computed Tomography: A Paradigm Shift in Dental Imaging

A CURSORY GLANCE of the literature in PubMed will reveal just over 4,000 articles that are directly or indirectly connected to cone beam computed tomography (CBCT). Witnessing the birth and ascent of CBCT and its adaptation in the practice of Oral & Maxillofacial Radiology was exciting. In 1998, an article published by Mozzo and co-workers[1] in the journal *European Radiology* laid the foundation for the new revolution in 3D imaging, as the authors explained how this volumetric CT machine would be useful for dental imaging. For decades, dentistry depended upon a flattened 2D image with no depth. CBCT, a low-dose, high resolution digital imaging technology provided the imaging for the other two planes. True to the article, CBCT became very relevant; a third dimension is often needed for diagnosis.

CBCT imaging can be utilized in all aspects of dental care for precise treatment planning and better prognosis for our patients. This is especially true in specialties like periodontics, endodontics, pedodontics and orthodontics. Oral and maxillofacial surgeons, prosthodontists, and oral medicine specialists traditionally used multi-detector CT (MDCT) or multi-slice CT (MSCT) as they needed technology that would show soft tissue enhancement and be covered under medical insurances. The introduction of the CBCT added significant value to their treatment planning because of its lower dose of radiation.

CBCT is a new standard for pre-implant imaging and treatment planning for implants, including the engineering of surgical stents, which aid in implant placement[2]. Designing can be completed digitally using the CBCT volume (dicom file format) with a proprietary software and can be saved into special file formats (.stl) that can be used for 3D printing and laboratory manufacturing of surgical stents. The same technology can be utilized for printing stereolithographic models that are used in orthognathic or tumor-related mock jaw surgeries. Large CBCT Fields of View (FOV) are acquired with resolutions ranging from 200-400 µ meters (microns). In specialties like endodontics or periodontics, small volume CBCT imaging using pixel sizes as small as 60-70 µ meters can be utilized to view PDL space, furcation defects, root anatomy, fractures, and complex pulp pathways that would otherwise be hard to assess using 2D imaging alone. Children and adolescents need a CT with lowered dose, and therefore, CBCT would be their choice of imaging modality. The FOVs can be tailored to suit the imaging needs in pedodontics, simultaneously reducing the effective doses [E] (table 1), as collectively, we have an obligation to our patients to reduce the dose as low as reasonably achievable (ALARA)[3].

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Table 1: Showing common head and neck radiographic procedures and their equivalent approximate doses and equivalent number of days of background radiation

Radiographic procedure	Radiation dose in Micro Sieverts (× Sv)	Equivalent days of natural background radiation (average per person in the US = 3100 ×Sv/yr or 8.4 ×Sv /day)
1PA	<1.5	0.2
FMX (18 images)	~27	3.2
PAN	2.7 - 24.3	2.8 computed with highest possible dose
Cephalometric radiograph	<6	0.7
CBCT craniofacial	30-1073	127 computed with highest possible dose
CBCT dento-alveolar	11-674	80 computed with highest possible dose
MSCT craniofacial	280-1410	167 computed with highest possible dose

Sources: www. SEDENTEXCT.eu; hps.org/documents/background_radiation_fact_sheet.pdf

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2017 LINDBACK AWARDEE

The University of Pennsylvania recognized Dr. Mel Mupparapu for his excellence in teaching as a recipient of Penn's 2017 Christian R. and Mary F. Lindback Foundation Awards for Distinguished Teaching. Penn presents eight Lindback awards each year, divided evenly between health-related disciplines and all other departments and divisions of Penn. Award winners are determined by nominations and recommendations of faculty and students.

Dr. Mupparapu has held the position of Professor since 2012 and has served as Program Director of the Oral & Maxillofacial Radiology Fellowship since 2014. Dr. Mupparapu lectures within the graduate dental education and predoctoral DMD programs.

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Switching to CBCT technology from MDCT /MSCT resulted in shorter scan time, selective beam limitation, greater image accuracy, reduced patient dose, user-friendly interactive display models, multiplanar reformation (including panoramic reconstructions), 3D volume rendering, and simulated cephalometric and skull views (via *"Ray Sum"* or *"Ray Casting"*) to name a few[4]. The most fascinating part of CBCT technology is its ability to procure datasets that are isotropic in nature, as the acquisition of basis images in this technology depend on the pixel size of the detector rather than the acquisition of groups of rows with sequential translational motion leading to columnar images where heights differ from the width and depth dimensions (Anisotropic)[4]. In other words, CBCT images are less prone to distortions and remain anatomically accurate in all viewing planes.

CBCT volumes also have their share of artifacts, but these can be minimized if the acquisition protocols are properly followed and patient motion is minimized. Metallic restorations that lead to beam-hardening artifacts are a common issue, so researchers are developing algorithms to reduce them to an acceptable level for interpretation. Overall, CBCT imaging is a technology that is here to stay. ■

REFERENCES

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