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Effective dose range for cone beam computed tomography scanners

Ruben Pauwels[1], Jilke Beinsberger[1], Chrysoula Theodorakou[2], Anne Walker[2], Lesley Cockmartin[3], Hilde Bosmans[3], Reinhilde Jacobs[1], Ria Bogaerts[4], Keith Horner[5], The SEDENTEXCT Project Consortium[6]

[1]Oral Imaging Center, School of Dentistry, Oral Pathology and Maxillofacial Surgery, Faculty of Medicine, Catholic University of Leuven, Belgium.
[2]North Western Medical Physics, The Christie NHS Foundation Trust, Manchester, UK.
[3]Department of Radiology, University Hospital Gasthuisberg, Leuven, Belgium.
[4]Department of Experimental Radiotherapy, University Hospital Gasthuisberg, Katholieke Universiteit Leuven, Belgium.
[5]School of Dentistry, University of Manchester, UK.
[6]Listing of partners on www.sedentexct.eu

Objectives: CBCT has proven to be a useful tool for many dental applications, and has shown many benefits on different levels compared to conventional radiographic techniques and multi-slice CT. However, there is limited and inaccurate information regarding the patient dose for different scanners and protocols. The objective of this study was to estimate the absorbed organ dose and effective dose for a wide range of cone beam computed tomography scanners, using different exposure protocols and geometries.

Methods: Two Alderson Radiation Therapy anthropomorphic phantoms were loaded with 147 LiF detectors (TLD-100 and TLD-100H) which were evenly distributed throughout the head and neck, covering all radiosensitive organs. Measurements were performed on 14 CBCT devices: 3D Accuitomo 170, GALILEOS Comfort, i-CAT Next Generation, Iluma Elite, Kodak 9000 3D, Kodak 9500, NewTom VG, NewTom VGi, Pax-Uni3D, Picasso Trio, ProMax 3D, SCANORA 3D, SkyView, Veraviewepocs 3D. Where possible, different exposure protocols were applied, varying the mAs and the position and size of the field of view. Effective dose was calculated using the ICRP 103 (2007) tissue weighting factors for brain, salivary glands, thyroid gland, red bone marrow, bone surface, and skin.

Results: Effective dose ranged between 10 and 150 µSv. The largest contribution to the effective dose was from the salivary glands, thyroid gland and red bone marrow. For all organs, there was a wide range of measured values apparent, due to the difference in the amount and energy of the exposure, the diameter and height of the primary beam, and the positioning of the beam relative to the radiosensitive organs.

Conclusions: Considering that the effective dose for different CBCT devices showed a 15-fold range, the results show that it is not suitable to look upon dental CBCT as a single modality. A distinction is needed between small-, medium-, and large-field CBCT scanners and protocols, as they are applied to different indication groups, and the difference in field size is clearly reflected in the dose received. Furthermore, the dose should always be considered in relative to technical and diagnostic image quality, seeing that image quality requirements also differ for patient groups. The results from the current study provide an indication that the optimisation of dose should be performed by an appropriate selection of exposure parameters and field size, depending on the diagnostic requirements. This rational paradigm is not being applied in CBCT practice yet, because of the gap of knowledge

regarding CBCT dose and image quality, the former of which was addressed by the current study.

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