

Cone Beam Computed Tomography

radiation dose and image quality assessments

AKADEMISK AVHANDLING

som för avläggning av odontologie doktorsexamen vid Sahlgrenska akademien vid Göteborgs universitet kommer att offentlig försvaras i föreläsningssal 3, institutionen för odontologi, Medicinaregatan 12D, Göteborg, fredagen den 17 december 2010, kl. 9.00

av

Sara Lofthag-Hansen
leg tandläkare

Fakultetsopponent:
Docent Jan Ahlqvist, Umeå universitet, Umeå

Avhandlingen är baserad på följande delarbeten:

- I Lofthag-Hansen S, Huumonen S, Gröndahl K, Gröndahl H-G.
Limited cone-beam CT and intraoral radiography for the diagnosis of periapical pathology
Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 103: 114-19
- II Lofthag-Hansen S, Gröndahl K, Ekestubbe A
Cone-beam CT for preoperative implant planning in the posterior mandible: Visibility of anatomic landmarks
Clin Implant Dent Relat Res. 2009; 11: 246-55
- III Lofthag-Hansen S, Thilander-Klang A, Ekestubbe A, Helmrot E, Gröndahl K.
Calculating effective dose on a cone beam computed tomography device: 3D Accuitomo and 3D Accuitomo FPD
Dentomaxillofac Radiol 2008; 37: 72-79
- IV Sara Lofthag-Hansen, Anne Thilander-Klang, Kerstin Gröndahl
Evaluation of subjective image quality in relation to diagnostic task for cone beam computed tomography with different fields of view
Eur J Radiol 2010; doi:10.1016/j.ejrad.2010.09.018



GÖTEBORGS UNIVERSITET

Cone Beam Computed Tomography radiation dose and image quality assessments

Sara Lofthag-Hansen

Department of Oral and Maxillofacial Radiology, Institute of Odontology at Sahlgrenska Academy, University of Gothenburg, PO Box 450, SE-405 30 Göteborg, Sweden

Abstract

Diagnostic radiology has undergone profound changes in the last 30 years. New technologies are available to the dental field, cone beam computed tomography (CBCT) as one of the most important. CBCT is a catch-all term for a technology comprising a variety of machines differing in many respects: patient positioning, volume size (FOV), radiation quality, image capturing and reconstruction, image resolution and radiation dose. When new technology is introduced one must make sure that diagnostic accuracy is better or at least as good as the one it can be expected to replace. The CBCT brand tested was two versions of Accuitomo (Morita, Japan): 3D Accuitomo with an image intensifier as detector, FOV 3 cm x 4 cm and 3D Accuitomo FPD with a flat panel detector, FOVs 4 cm x 4 cm and 6 cm x 6 cm.

The 3D Accuitomo was compared with intra-oral radiography for endodontic diagnosis in 35 patients with 46 teeth analyzed, of which 41 were endodontically treated. Three observers assessed the images by consensus. The result showed that CBCT imaging was superior with a higher number of teeth diagnosed with periapical lesions (42 vs 32 teeth).

When evaluating 3D Accuitomo examinations in the posterior mandible in 30 patients, visibility of marginal bone crest and mandibular canal, important anatomic structures for implant planning, was high with good observer agreement among seven observers.

Radiographic techniques have to be evaluated concerning radiation dose, which requires well-defined and easy-to-use methods. Two methods: CT dose index (CTDI), prevailing method for CT units, and dose-area product (DAP) were evaluated for calculating effective dose (*E*) for both units. An asymmetric dose distribution was revealed when a clinical situation was simulated. Hence, the CTDI method was not applicable for these units with small FOVs. Based on DAP values from 90 patient examinations effective dose was estimated for three diagnostic tasks: implant planning in posterior mandible and examinations of impacted lower third molars and retained upper cuspids. It varied between 11-77 μ Sv.

Radiation dose should be evaluated together with image quality. Images of a skull phantom were obtained with both units varying tube voltage, tube current, degree of rotation and FOVs. Seven observers assessed subjective image quality using a six-point rating scale for two diagnostic tasks: periapical diagnosis and implant planning in the posterior part of the jaws. Intra-observer agreement was good and inter-observer agreement moderate. Periapical diagnosis was found to, regardless of jaw, require higher exposure parameters compared to implant planning. Implant planning in the lower jaw required higher exposure parameters compared to upper jaw. Substantial dose reduction could be made without loss of diagnostic information by using a rotation of 180°, in particular implant planning in upper jaw.

CBCT with small FOVs was found to be well-suited for periapical diagnosis and implant planning. The CTDI method is not applicable estimating effective dose for these units. Based on DAP values effective dose varied between 11-77 μ Sv (ICRP 60, 1991) in a retrospectively selected patient material. Adaptation of exposure parameters to diagnostic task can give substantial dose reduction.

Keywords: Cone beam computed tomography, anatomic landmarks, dose-area product, image quality, implant planning, periapical diagnosis, radiation dosimetry.

Swedish Dental Journal Supplement 209, 2010

ISBN 978-91-628-8205-1, ISSN 0348-6672

Correspondence: e-mail: sara.lofthag-hansen@vregion.se