

Radiation Safety in Dentistry

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Introduction

Radiographs are an indispensable diagnostic aid in dentistry as they allow the detection of disease and other abnormalities, as well as disease progression to be monitored. However, exposure to ionizing radiation also carries the risk of harm. Adverse effects of ionizing radiation can be divided into deterministic and stochastic effects. Deterministic effects have a threshold level below which no damage will occur and their severity increases with dose. It has been suggested that a cataract is a typical deterministic effect on the eye and may be caused by lower doses than previously considered.[1] Stochastic effects, including carcinogenesis, result from DNA damage.[1] The approach internationally adopted for risk estimation is the “linear-no-threshold (LNT)” model, which assumes a linear relation between exposure and risk down to zero dose.[1] This relationship has been demonstrated to be linear above a dose of 100 mGy. Below this dose, no direct evidence of increased risk exists.

Effective dose

The effective dose for common dental imaging varies widely, ranging from around 1.5 μ Sv for intraoral radiographs to between 2.7 to 24 μ Sv for panoramic radiography.[2] Effective dose ranges for Cone Beam Computed Tomography (CBCT) can be much larger: 11 to 1073 μ Sv.[2] Because of this wide range, dentists should choose their imaging wisely. Particular attention should be paid to children as they are substantially more susceptible to radiation risk than adults.[3,4] This policy statement is intended to assist the dentist in optimizing protection and keeping the diagnostic value of their radiographs, whilst minimizing the risk to patient, staff and the public.[5] Specific selection criteria have been developed to aid the dentist in determining the need for radiographs.[6-8] Pregnant patients should receive dental imaging only when specifically indicated to manage their dental care. Extra care regarding justification should be exercised for pediatric patients due to their markedly 32 times higher radiation sensitivity.

Justification for radiation exposures

Justification is the concept that a dentist needs to decide that a radiograph should be made when a patient is likely to benefit from exposure to diagnostic imaging. An initial clinical examination is required to determine the need for imaging of some or all of the tooth-bearing regions and surrounding hard tissues. Follow-up or periodic examinations to detect the presence of carious lesions and other conditions in areas that are not clinically accessible to direct view may require radiographic imaging. The frequency of such examinations will vary with patient considerations such as age, caries history, oral hygiene, history of periodontal or endodontic treatment, and other factors.

Optimization of radiographic exposures

Optimization is the concept that a radiograph should be of sufficient diagnostic quality, keeping the dose to the patient as low as diagnostically acceptable (ALADA).^{*} It is important to note that most means of reducing patient exposure also reduce exposure to the dental office personnel.

Statement

The amount of radiation exposure from conventional dental radiographs is low but the exposure from CBCT may be much higher. Radiographs should only be made when there is an expectation that the diagnostic yield will affect patient care. All reasonable means should be used to reduce radiation exposures, without compromising diagnosis, when radiographs are made.

Means for the dental office to minimize radiation exposure

Exposure justification	The exposure should yield diagnostic information that will influence patient care.
Image receptors	Film: use the fastest speed available – currently F-speed. Film should be processed according to the manufacturers instructions. A proper safe light should be used. Digital: Charged Couple Device (CCD), Complementary metal-oxide semiconductor (CMOS) and storage phosphor receptors are acceptable.
Receptor holders	Use to optimize alignment and minimize repeat exposures.
Beam collimation	For intraoral radiographs limit beam diameter to 6 or 7cm or smaller ³ ** at the patient's face and preferably with rectangular collimation. For all other radiographs, collimate the beam to the area under investigation.
kVp, mA & exposure time	For intraoral radiographs preferably use 60 – 70 kVp to optimize contrast and reduce depth dose. Reduce exposure time and/or mA when applicable. Use machines with automatic exposure controls when available. If not, use technique charts or other appropriate means to minimize over- or underexposures.
Operator protection	Operators should stand out of the primary beam, at least 2m away from the source, and behind a protective barrier whenever possible.
Hand-held units	Where permitted, hand-held units should be stored in a locked facility when not in use and should always be used with a shielding ring and held close to the patient's face.
CBCT	When indicated and when lower-dose techniques are not sufficient, use the smallest field of view sufficient to answer the clinical question and doseminimizing procedures such as half-

	cycle exposures when appropriate. Imaging data sets may need to be interpreted by an oral and maxillofacial radiologist.
Patient shielding	Use leaded aprons and thyroid collars whenever possible**.
Quality Assurance	Protocols should be developed and followed for assessing the integrity of the xray machine, film processor, digital image receptors, panoramic cassettes, and darkroom.[6]
Image viewing	Radiographs should be viewed and evaluated on appropriate, quality assured viewing boxes (film) or monitors (digital) in a darkened environment.
Education and training	Persons operating x-ray devices must have appropriate training, education and certification.

Notes

* ALADA was proposed by Dr. Jerrold Bushberg at the 2014 NCRP Annual Meeting as a variation of the acronym ALARA (as low as reasonably achievable) to emphasize the importance of optimization in medical imaging.

** National/local regulations may apply

References

1. International Commission on Radiological Protection. The 2007 Recommendations of the International Commission on Radiological Protection. Annals of the ICRP; 2007.
2. European Commission. Radiation Protection No. 172: Cone Beam CT for Dental and Maxillofacial Radiology. 2012.
3. UNSCEAR. Sources, effects and risks of ionizing radiation. Scientific Annex B. Effects of radiation exposure of children. New York: United Nations; 2013. Available at: http://www.unscear.org/docs/reports/2013/UNSCEAR2013Report_AnnexB_Childr...87320_Ebook_web.pdf
4. Kleinerman RA. Cancer risks following diagnostic and therapeutic radiation exposure in children. *Pediatr Radiol* 2006;36 Suppl 2:121-125.
5. White S, Mallya S. Update on the biological effects of ionizing radiation, relative dose factors and radiation hygiene. *Aust Dent J.* 2012;57 Suppl 1:2-8.
6. European Commission. Radiation Protection 136 - European guidelines on radiation protection in dental radiology; the safe use of radiographs in dental practice. European Commission 2004.
7. American Dental Association Council on Scientific Affairs. Dental Radiographic Examinations: Recommendations for Patient Selection and Limiting Radiation Exposure; 2012. Available at: http://www.ada.org/~media/ADA/About%20the%20ADA/Files/dental_radiograph...

8. Guideline on Prescribing Dental Radiographs for Infants, Children, Adolescents, and Persons with Special Health Care Needs. http://www.aapd.org/media/Policies_Guidelines/E_radiographs.pdf