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Paediatric Imaging Working Group

Managing Cone Beam CT Dose in Paediatric Dental Imaging

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Introduction

- Cone beam CT (CBCT) has been widely used in dentistry for over 10 years (Li, 2013).
- CBCT technology can provide multiple viewing angles and 3D reconstructions, which help in a more complete evaluation as compared to conventional dental imaging modalities (panoramic radiography, intraoral, etc.).
- The doses associated with CBCT span a considerably wide range, depending a lot on the equipment (Li, 2013; Ludlow et al., 2008; Pauwels, 2012).
- CBCT doses are generally lower than multidetector CT (MDCT) doses (Li, 2013).
- CBCT doses are generally higher than the doses from conventional dental radiography (Li, 2013).

Doses for dental exposures
(In general. Not just for children)

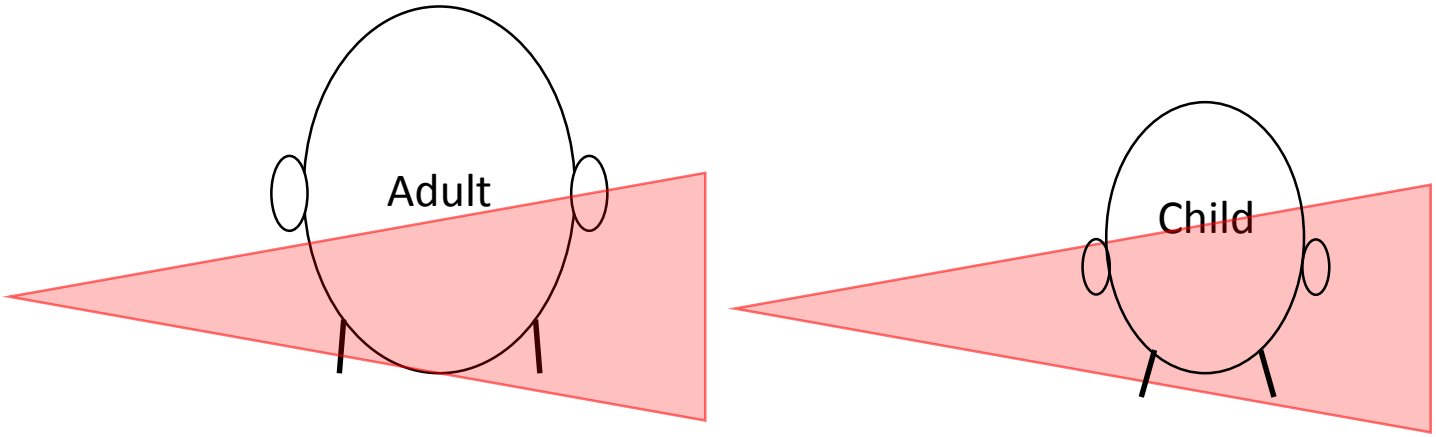
Radiographic technique	Effective dose (µSv)
Intraoral radiograph	0.3-21.6
Panoramic radiograph	2.7-38
Lateral cephalometric radiograph	2.2-14
CBCT	11-1025 (generally <300)
CT (mandible)	250-1410
CT (mandible & maxilla)	430-860

Reproduced from: IAEA, 2017. Radiation Protection in Dental Radiology

L09 Justification and appropriate use of dental radiology

Introduction

- Children are more sensitive to radiation than adults (Aps, 2013; IAEA, 2017).
- Children also have longer life expectancy than adults. This means that the potential long term effects (cancer) due to past irradiations have more time to develop and manifest.
- Dose to children is higher than dose to adults using the same exposure parameters. The same size of field-of-view (FOV) will cover a larger region in the case of a child.



Adapted from: IAEA, 2017 Radiation Protection in Dental Radiology

Introduction

Taking into account that:

- The possibility of radiation induced stochastic effects (cancer) cannot be ruled out
- The probability of stochastic effects is cumulative
- The frequency of dental radiographic examinations is high in children (IAEA, 2017)

Practitioners always need to keep radiation doses at the lowest reasonably achievable levels (ALARA Principle)

Justification and Optimisation

- Literature regarding the indications for CBCT use in dentomaxillofacial paediatric imaging remains limited (Oenning et al., 2017).

- Thus, the appropriate use of CBCT in paediatric dental imaging needs to be based on proper justification and optimisation of examinations. Applying the basic principles of radiation protection should suffice for safe CBCT use in children (Aps, 2013).

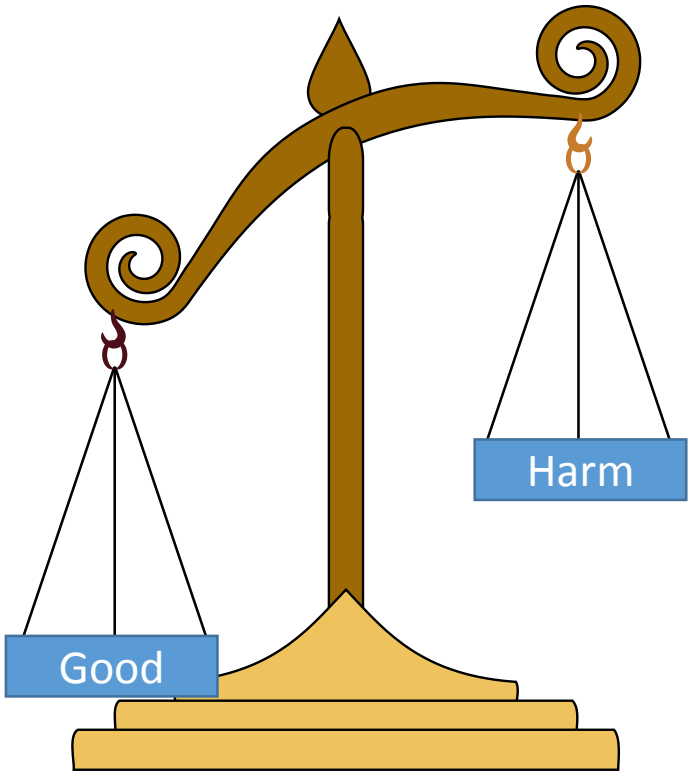
Justification

Optimisation

Justification

- Justification is related to the appropriate selection of an imaging technique in a given situation (IAEA, 2017).
- "Any decision that alters the radiation exposure situation should do more good than harm." (ICRP 103, 2007).

- **Justification of medical exposures is more stringent in children (IAEA, 2017).**
- Because of the complexity and uncertainty of the process; The assessment of risk vs benefit should be performed at an **individual patient basis** and the benefit should clearly outweigh the risk (Aps, 2013; IAEA, 2017).



Justification

- Justification should take dose into account.
- Patients should not be subjected to screening or routine imaging examinations just because they are new to a dental practice.
- Dentists should try to get as much relevant information as possible from previous examinations, patient history and clinical examination.
- Care should be taken to **AVOID REPEAT SCANS.**

Adapted from: IAEA, 2017. Radiation Protection in Dental Radiology
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Justification
*CBCT or MDCT? (If no other modality can be used. General information. **Not only for children**)*

- CBCT advised when:
  - High sharpness is needed when compared with MDCT (e.g. small anatomy/pathology)
  - Only a localized region needs to be scanned (e.g. single tooth region); large amount of dose can be saved through horizontal collimation
- MDCT advised when:
  - Soft tissue discrimination is needed
  - Neurological symptoms
  - Contrast agent needed
  - MRI not available
- Not unequivocally clear for certain applications whether CBCT or MDCT provides better diagnostic image quality at the same dose

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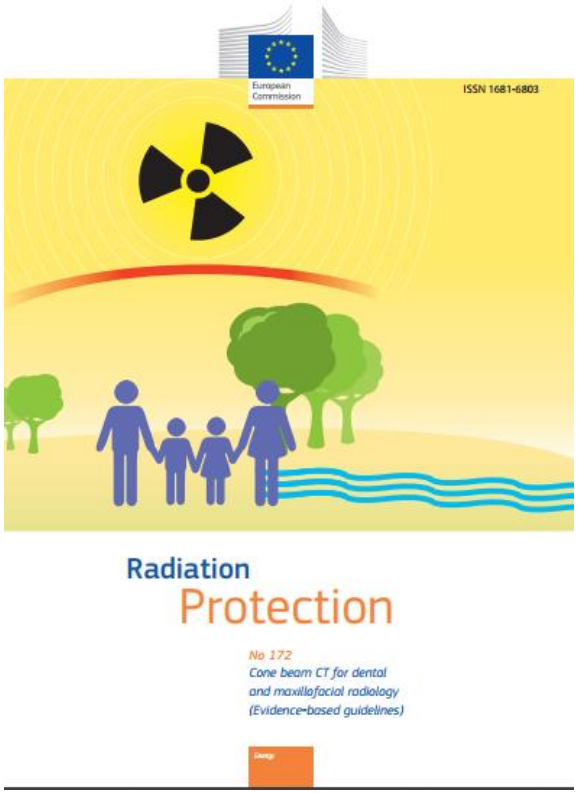
Justification
Further Information - Referral Criteria

- Cone beam CT for dental and maxillofacial radiology (Evidence-based guidelines) (EC RP 172, 2012).
- UK: Selection Criteria for Dental Radiography (Faculty of General Dental Practice).
- Other national guidelines.



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Optimisation

- Use child sized protocols which should be reviewed and optimised periodically (IAEA, 2017).
- A tube voltage of 90 kVp results in lowest doses for all sizes of patients (Pauwels et al, 2017).
- Use lowest possible mAs keeping the image quality at clinically acceptable levels. Using lower mAs leads to larger dose reductions than lower kVp. Dose reduction up to 50% was can be achieved by reducing mAs for small head sizes (Pauwels et al., 2017; IAEA, 2017).
- Use the lowest resolution needed to get the desired clinical information (**prefer larger voxel sizes than smaller ones**) (Librizzi et al., 2011).
- Reduce field of view to the minimum possible.

Optimisation

- Shield the thyroid of patients. The thyroid gland seemed to receive four times more radiation in a 10-year-old than in an adolescent because of the anatomy of the patient (Theodorakou et al., 2012).
- Qu et al. (2012) reported dose reduction of approximately 50% to the thyroid when collar was used.
- Do not use thyroid shielding if region of interest is at the vertical level of the shielding (use scout image to verify) (IAEA, 2017; Hidalgo et al., 2015)
- Consider using lead goggles in case of imaging the orbita. Up to 67% dose reduction has been observed (Prins et al., 2011).
- Keep in mind that CBCT does not provide as good soft tissue differentiation as MDCT or MRI.
- “Stitching” of multiple scans may lead to higher doses. Horizontal “stitching” is discouraged (IAEA, 2017).

Optimisation

- Consider the artefacts before deciding to expose paediatric patients to CBCT. If you expect them to be very bad, consider alternate imaging methods (Aps, 2013).
- Use a quality assurance scheme for your equipment and processes.
- Perform patient dosimetry.
- Diagnostic reference levels (CBCT DRLs are not widely available yet); There is need for optimisation in CBCT (IAEA, 2017).

Conclusions

- Pediatric Dental CBCT dose can be reduced if appropriate, personalised justification and proper techniques are used.

- Dentists should avoid routine CBCT scans and always consider conventional radiographic imaging methods if possible.

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