Session 8:
Radiation Protection of Patients and Staff Where Procedures are Performed Outside Radiology Departments

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Major Thematic Areas

- Paediatric Exposures
  - Standardization of procedures
  - Transition from film to digital radiography
  - 2D versus 3D imaging
- Dental Cone Beam CT
  - Development of guidelines
  - Dosimetry
  - Effectiveness of lead aprons
  - RP Training

Paediatric (1)

R.R. JAKUBIAK (Brazil) et al; OPTIMIZATION OF PEDIATRICS CHEST EXAMS AT INTENSIVE CARE UNITS

- The main objective of the study is to reduce the radiation dose to patients due to repetition and the lack of standardized procedures. Chest exams are most commonly performed in the ICU.
- Technical chart contains parameters (voltage, current, exposure time and distance to source receiver) appropriate for each anatomical region for children (0-2 yrs).
- The technical charts must be used as a guide because they need to be adjusted daily according to the clinical condition of the patent at the time of exposure.

Paediatric (2)

C.MUCHUKI (Kenya) et al; DOSE REDUCTION IN TRAUMA PATIENTS PERFORMED USING PORTABLE EQUIPMENTS AT KENYATTA NATIONAL HOSPITAL, KENYA

- This study was part of an IAEA project (RAF/0/033) to “Strengthen Radiological protection of patients and medical exposure control.”
- Survey gives preliminary results of medical radiation exposures due to chest examinations to children using portable x-ray equipment and film cassettes.
- Patient doses compare well with international reference dose levels.
- Study recommends developing x ray exposure chart for each unit; adherence to x-ray equipment maintenance and repair schedules; stressing appropriate film storage and processing conditions (film fogging and darkroom light leakage); and proper use of safety equipment

Paediatric (3)

R. SANCHEZ (Spain) et al; IMPLEMENTATION OF DIGITAL RADIOGRAPHY IN A NEONATAL INTENSIVE CARE UNIT. ASSESSING THE ROLE OF CLINICAL AUDITS IN AVOIDING UNNECESSARY PATIENT IMAGING AND RADIATION EXPOSURE

- Investigate variations in radiation exposure after the implementation of DR in a NICU. Comparison of number of exams from 2000-2004 (pre-DR) versus 2006-2010 (DR)
- The total number of portable radiography images per patient in the NICU increased 8.1% after adjusting for severity of illness during the transition to digital radiography.
- Transition to digital radiography may reduce patient dose from portable exams.
- Proactive strategies are required during this transition to avoid unnecessary exposures. Clinical audits and referral criteria guidelines should be stressed to avoid unnecessary images

Paediatric (4)

N. LUNELLI (Brazil) et al; RADIATION EXPOSURE TO PAEDIATRIC PATIENTS IN CEREBRAL PROCEDURES

- Digital subtraction angiography techniques are increasingly being used to for the diagnosis and treatment of vascular malformations. However, few publications on paediatric doses in neurointerventional procedures.
- Objective of the study was to estimate paediatric patient doses received during cerebral procedures. 15 patients evaluated. TLDs used to determine dose at selected points (thyroid, eyes).
- Doses to the eyes are not negligible (mean 33 mGy air kerma to the left eye). Lifetime risk for lens opacities and cataracts will increase if these patients undergo other procedures involving the eye lenses during their lifetime.
- Doses should be recorded in patient charts for future reference.

Dosimetry

J. VOIGT (Germany) et al; SIMULATION OF PATIENT EXPOSURE AT RADIUS FRACTURE DIAGNOSTICS USING 2D AND 3D IMAGING TECHNIQUES

- Patients under suspicion of a radius fracture conventionally undergo a two –plane projection 2D imaging (ap and lat). The exam often leads to no clear diagnostic findings. Next, patients undergo a 3D conventional CT exam.
- A Monte Carlo simulation with an ICRP adult male Voxel phantom were used to compare 2D and 3D imaging.
- Despite manufacturers claims that patient exposures are comparable for 2D and 3D images, this study demonstrated that a 3D exam using a dedicated extremity scanner delivers 2 to 3 times more dose compared to a 2D projection examination.
- It may save enormous dose if patients are directly scanned with dedicated extremity scanners

Radiation Protection

G. ZATELLI (Italy) et al; RADIATION EXPOSURE DURING ENDOVASCULAR ABDOMINAL AORTIC ANEURYSM REPAIR (EVAR)

- The aim of the study was to evaluate radiation protection aspects of the EVAR procedures used in the operating room(OT) compared with the angiosuite(AS)
- 100 procedures were analysed. Mean fluoroscopic times were similar in AS and OT. Recorded radiation exposure in the AS was significantly higher than the OT, but reduced by two fold without significant loss of image quality after implementing the low dose ‘carebody’ protocol.
- Doses to the lens of the eye were estimated for vascular surgeons and compared with new ICRP limits. The estimated Hp(3) to the unprotected lens is about 53 µSv for each procedure, which can be mitigated with proper use of lead eye glasses and suspended transparent shielding.
- Optimization processes and comparison with other vascular centers in needed

Cone Beam CT

- Recent years, CBCT equipment for dentists began to be manufactured in response to a need for cross-sectional imaging for implant dentistry.

- It is an attractive method, but it is associated with greater radiation dose than traditional dental radiographic methods, CBCT might be used inappropriately, without optimization of exposures, and with poor quality control procedures.

Cone Beam CT (1)

K.HORNER (United Kingdom); CONE BEAM CT FOR DENTAL AND MAXILLO-FACIAL RADIOBIOLOGY: THE DEVELOPMENT OF EUROPEAN EVIDENCE-BASED GUIDELINES

- Objective to develop evidence-based guidelines on use of CBCT in dentistry, including referral criteria, quality assurance guidelines, and optimization strategies.
- Guidelines were published (2011) as RP 172: Cone Beam CT for Dental and Maxillofacial Radiology. Evidence-based Guidelines. (details available at **www.sedentexct.eu**)
- Contains a comprehensive set of guidelines relating to the use of dental CBCT, developed by a multidisciplinary group using rigorous methodology. Wherever possible, the guidelines are evidence-based; but if this was not possible consensus processes were used.
- Sixty-eight guideline statements were developed, 43 are referral criteria or related to the justification process. CBCT is only indicated for certain situations. Doses are typically an order of magnitude greater than traditional radiographic techniques.
- Qualified expert is consulted over the installation and use of CBCT to ensure staff doses is ALARA. QA and training guidance is provided as well.

CBCT Dosimetry (1)

E. HELMROT (Sweden) et al; KERMA-AREA PRODUCT AS A DOSE INDICATOR IN DENTAL CBCT

- Dose indicators are used in diagnostic radiology for quality assurance and optimization.
- Aim of the work is to point out the importance of P_{KA} as a dose indicator in dental CBCT and estimate how corresponding conversion coefficients vary with field size and shift of reference point.
- Coefficients for converting P_{KA} to effective dose were calculated for three field sizes using a Monte Carlo Program for calculating patient doses in medical x-ray examinations.
- Compared to measurements with TLDs, the usage of dose indicators for routine optimizations in clinics is simpler and faster.
- P_{KA} should be used for setting DRLs and accurate conversion coefficients should be available to improve optimization processes.

CBCT Dosimetry (2)

M. ANDRADE (Brazil) et al; ORGAN DOSES AND AIR KERMA-AREA PRODUCT FROM DENTAL CONE BEAM COMPUTED TOMOGRAPHY SCANNERS

- The aim of the study is to compare the absorbed doses to relevant organs and the air kerma-area product for two CBCT scanners (i-CAT and PreXion).
- Organ doses were measured with TLDs inserted into a RANDO phantom. For both protocols (S and HR), the organ doses measured for the i-CAT were smaller than those measured for the PreXion 3D scanner. The small FOV for the PreZion offset the higher P_{KA} compared with the i-CAT.
- Effective doses for HR protocols were about two times higher than the Standard protocol. Use of high resolution protocols without any criteria may contribute to elevated patient absorbed doses and associated radiation risks. Eye, thyroid, and salivary gland absorbed doses from dental CBCT are not negligible and should be recorded in patient records.

CBCT Dosimetry (3)

G. ZHANG (Belgium) et al; ORGAN ABSORBED DOSE AND THE EFFECTIVE DOSE CALCULATED USING COMPUTATIONAL ANATOMICAL PHANTOMS FOR DEDICATED CONE BEAM ORAL AND MAXILLOFACIAL CT

- Experimental dose determination mainly relies on phantoms loaded with TLDs, a costly, labor intensive approach with high uncertainty.
- This study uses Monte Carlo modeling approach with four computational phantoms to estimate dose for CBCT of the oral and maxillofacial region.
- Simulation framework includes x-ray generation, filtration, collimation, characterized beam quality, and rotational CB image acquisition geometry.
- Study demonstrated that the Monte Carlo approach is more efficient than experimental measurements for dose determination and the model can be implemented to different CBCT systems.

CBCT Dosimetry (4)

D. ROTTKE (Germany) et al; DOSIMETRY AND THE USE OF A LEAD APRON IN DENTAL RADIOGRAPHIC MODALITIES

- The aim of the study was the in vitro evaluation of energy doses in different sites of a human full body phantom. TLDs were placed in 55 different sites.
- Three different machines in panoramic radiograph (PR) and/or cone beam CT mode were examined.
- The results showed that there was no significant different between the protocols using a lead apron and those that do not. The results show a similar distribution of the energy doses along the phantom in the related protocols.

	mean [µGy]	median [µGy]	max [µGy]	min [µGy]	range [µGy]
Device 1, PR	*107.8*	*75.6*	*439,8*	*4,6*	*435,2*
Device 1, PR apron	*106,5*	*71,2*	*450,5*	*3,8*	*446,6*
Device 1, CBCT	*951,1*	*137,1*	*5474,3*	*9,0*	*5465,2*
Device 1, CBCT apron	*957,8*	*133,4*	*5534,1*	*10,8*	*5523,3*
Device 2, PR	*87,6*	*47,1*	*472,2*	*2,3*	*469,9*
Device 2, PR apron	*87,7*	*54,8*	*449,3*	*5,1*	*444,2*
Device 3, CBCT	*627,6*	*154,0*	*2520,3*	*25,8*	*2494,5*
Device 3, CBCT apron	*634,3*	*163,8*	*2560,2*	*35,4*	*2524,8*

Dental RP Training

J. VASSILEVA (Bulgaria) et al; RADIATION PROTECTION TRAINING FOR DENTAL STUDENTS – EXPERIENCE IN BULGARIA

- EC Medical Exposure Directive: “Member States shall encourage the introduction of a course on radiation protection in the basic curriculum of medical and dental schools.”
- 15 hours training module introduced in 2005 to introduce basics of image formation, types of imaging modalities, image quality parameters, basic principles of radiobiology, and approaches to patient and staff radiation protection.
- Final aim – increase understanding on how to obtain diagnostic images at minimum exposure to patient and medical staff.
- Knowledge is assessed with a multiple choice examination.
- The radiation protection training module has been successfully integrated into the clinical training with increased interest and awareness of radiation protection amongst dental students.