DIMITRA: Dentomaxillofacial paediatric imaging: an investigation towards low dose radiation induced risks

DIMITRA consortium
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AIM:
This project focuses on the uncertainties associated with radiation-induced health risks at low doses in paediatric dentistry. It is a multidisciplinary effort to approach the involved risks through four different yet interrelated tasks: radiobiological characterization, dosimetric quantification, epidemiological surveying and image quality & dose optimization.

TASK 1: Characterising the risks

I. Orofacial (stem) cells will be exposed to low doses of X-irradiation (0.5, 5, 10, 20, 50 and 100 mGy). DNA damage and repair kinetics (via yHAX2 visualization) will be assessed along with the profile of secreted proteins (e.g. cytokines). The obtained results will enable specification of potential X-ray-induced markers.

II. Saliva

III. Orofacial (stem) cells

II. Oral epithelial cells will be collected in paediatric patients undergoing CBCT. yHAX2 foci will be used as a biomarker to detect DNA damage and repair in the low dose range in these exfoliated oral epithelial cells. In addition, ODB repair protein MEH2 will also be used as a marker of radiation-induced DNA damage.

III. Saliva, the ‘mirror of the body’, has its own proteome containing numerous biomarkers that are also found in plasma. These proteins can reflect the physiologic state of the body. A pilot study will be set up to analyse oxidative stress by measuring the expression of 8-oxo-7,8-dihydro-2-deoxyguanosine in saliva collected from paediatric patients before and after CBCT examinations.

TASK 2: Quantifying the doses

I. An EGSnrc-built Monte Carlo (MC) framework has been developed and customized for dosimetric applications in dental CBCT (fig.3). The dosimetric platform has been configured to model the spectral, geometric and rotational characteristics of a Promax 3D Max (Planmeca, Helsinki, FIN) and a Vigi-evo (Newtom, Verona, IT) scanner. The validity of the MC dose calculations has been tested against experimentally obtained dose measurements in water for every clinical protocol (max. 7%).

II. Patient specific voxel models (age and gender equivalent) will be used as a tool to compare dose and referred pathologies. The effective dose for CBCT was estimated by using DAP value and conversion coefficients for CBCT calculated in Task 2. The effective dose for 2D radiography was calculated using conversion factor of 0.75kV.

III. Each patient-specific voxel model will be loaded to the scanner and referred pathologies. The effective dose for children was retrospectively estimated for every clinical protocol (max. 7%).

TASK 3: Surveying the risks through epidemiology

I. Retrospective analysis of dose on pediatric population will analyze a cohort group of patients aged between 0-22 years selected from four different oral radiology centers in Cluj-Napoca. The effective dose for children was retrospectively estimated based on the type of examination, equipment and settings, age and gender of the patients and referred pathologies. The effective dose for CBCT was estimated by using DAP value and conversion coefficients for CBCT calculated in Task 2. The effective dose for 2D radiography was calculated using conversion factor of Helmrot and Aim Carlson for 60-75kV and Batista equation for voltages >75kV.

II. Prospective analysis of dose response for CBCT examination will analyse the cumulative dose in children group based on their radiological records and a questionnaire that investigates all radiological exposure.

III. A Specific cohort of cleft lip and palate patients will estimate the cumulative dose for group of cleft palate patients compared to dose for children without cleft.

TASK 4 : Reducing risks through image quality optimization

I. Identification of common indications for paediatric CBCT and related image quality criteria

<table>
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<th>CLINICAL INDICATIONS</th>
<th>CLINICAL IMAGE QUALITY CRITERIA</th>
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<td>Ultra Low Dose 32 mGy.cm²</td>
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<tr>
<td>Sedentextx phantom</td>
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II. Subjective and objective image quality assessments from a range of CBCT protocols.

III. Guidelines regarding optimized protocols related to indications

RECOMMENDATIONS OF OPTIMIZED PROTOCOLS

Task 2 Dose

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