Absorbed and Effective Doses from the Intraoral Dental X-ray Radiography

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Introduction. Even if a medical exposure using ionizing radiation sources has a significant influence to the general population exposure, diagnostic medicine without X-ray radiography is impossible. The most freequently performed X-ray examinations are dental radiology examinations. The irradiation doses from the dental radiology are small enough to be neglected however sufficient enough to introduce secondary cancer. Measurement of the absorbed doses and evaluation of the effective doses allows assessment of radiation induced stochastic and deterministic effects.

Phantoms are ususlly used for irradiation doses measurements, since they can help to simulate real irradiation procedure taking into account biometric data of patients, including size and shape and also location of organs and tissues at risk. [1, 2].

The aim of this work was evaluation of the effective doses to patients obtained during intraoral dental X-ray radiography procedure.

Methods: Simulating intraoral X-ray examination procedure for lower jaw (Fig.1) absorbed and effective doses for organs at risk were evaluated using poly-methyl methacrylate (PMMA) slab phantom reconstructed from the CT scans of the real patient. 3D Slicer and Blender software was used for evaluation.

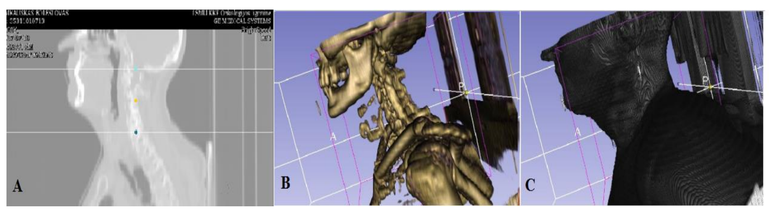


Figure 1. Chosen area of interest – head-neck area; A – CT scan; B – bone structure; C - soft tissue structure

Gafchromic films were used for the irradiation dose assessment. After irradiation the films were scanned with a scanner *HP Scanjet G400* (Fig. 2) keeping requested allignment of the film.

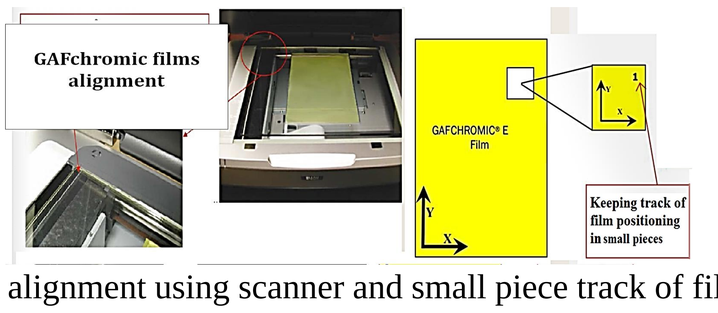


Figure 2. Film alignment using scanner and small piece track of film positioning

The absorbed doses for the critical organs were evaluated taking into account reconstructed in the reconstructed lower jaw phantom from the CT images. For the recalculation of the effective doses tissue weighting factors were applied (Fig. 3).

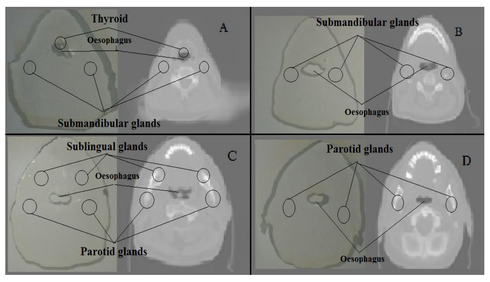


Figure 3. The slices of the head-neck area; A – neck; B, C, D – lower mandibular

Results. It was found, that the doses were ~60% lower applying digital image detectors as compared to the analogue dental X-ray equipment (Fig. 4).

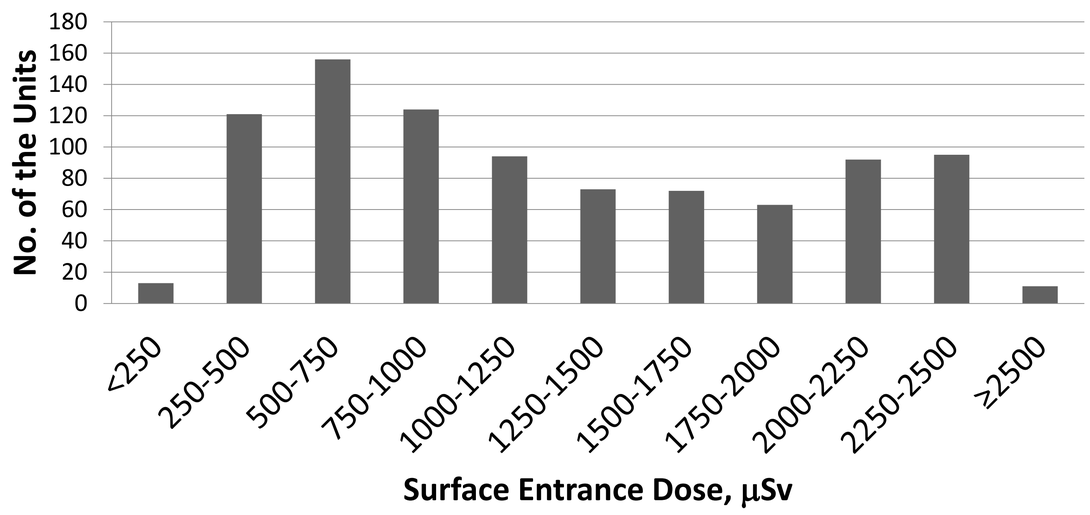
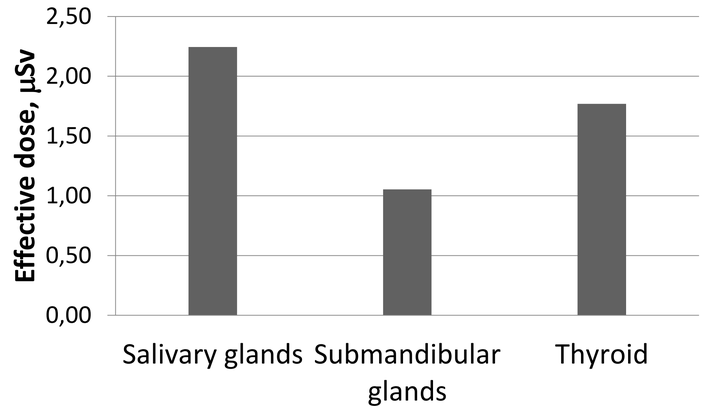


Figure 4. Surface entrance doses for the mandibular molar examinations

Absorbed doses measured using analogue technique was noticeable higher for the salivary glands and for oral mucosa. Recalculated effective doses varied from the 0.5 to 5.5 µSv depending on the technical irradiation parameters and field size/ collimation (Fig. 5).



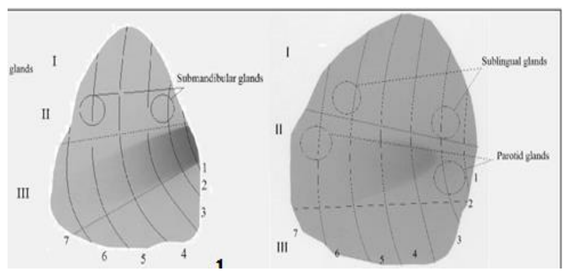


Figure 5. Effective dose distribution for the critical organs: salivary and submandibular glands and thyroid

Conclusions*:* Performed investigation has shown statistically significant dose variations during intraoral dental X-ray procedure that were related to the technical parameters of irradiation. This indicated an important issue of possible patient's dose reduction in intraoral dental X-ray radiography, which could be managed when selecting appropriate set of technical parameters for the examination. Some recommendations regarding patient's dose reduction are also provided.

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References

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2. V. Giacometti A. S. Guatelli A.. M. Bazalova-Carter B. A.B. Rosenfeld A. R.W. Schulte. Development Of A High Resolution Voxelised Head Phantom For Medical Physics Applications. Physica Medica. 2017.