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IMPACT OF DOSE TO PERIPHERAL ORGANS IN KVCBCT FOR IGRT PROSTATE CANCER RADIOTHERAPY: TLD MEASUREMENTS USING AN ANTHROPOMORPHIC PHANTOM

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Introduction: Radiation dose in Cone Beam Computed Tomography (CBCT) for pre-treatment verification has become a topic of high interest. This is to ensure that concomitant imaging dose to in-field organs does not exceed the dose criteria established for the treatment plan and to the concern for the associated second primary cancer induction risks (SPCR) in out-of-field (peripheral) organs. To minimize and justify this imaging dose, it's necessary to measure it. As for diagnostic CT, the traditional CTDI might be used. However, this parameter does not serve neither as an accurate representation of dose to critical organs, nor as a direct estimator of SPCR. The aim of this study was to measure the organ doses and the associated SPCR for a clinical pelvis CBCT protocol.

Material and method: A male 701-D ATOM phantom with 271 holes for TLD-chips dosimetry distributed in 20 predefined internal organs was used. The phantom weights 73 kg and only consists of the head and torso. The particular CBCT protocol for Image-guided radiation therapy (IGRT) for prostate cancer used at Clinica Alemana (120 Kv, 40mAs, 40 ms, cassette M20, F1, 360° rotation) was applied. The CBCT (Elekta XVI, Dunlee Philips Healthcare) was attached to the Elekta Synergy linear accelerator. TLD-100 had been previously cross-calibrated to an FC65-G in a 120kV beam of a Philips X-ray tube SRO33100 (HVL = 6.1 mm Al). Organ doses associated with one acquisition were estimated for 20 critical organs defined at ATOM and then multiplied by the 42 acquisitions used for the clinical IGRT protocol. Effective dose and total SPCR associated with such an exposure were calculated by using the best convergence of the organs defined in the ATOM phantom and the ICRP103 recommendations (see table 1).

Results: The primary X-ray beam of CBCT covered the following in-field organs: prostate, bladder, testes, and part of the intestine. After the 42 acquisitions, the maximum dose to organs was 112.1 cGy (for testes). Liver, pancreas and heart < 3 cGy. The prostate received 80.27 cGy (see figure 1). The effective dose and total SPCR was 232.6 mSv and 1.3% respectively.

Table 1: Organs defined in the ATOM phantom.

Organs		
Brain*+	Liver*+	Stomach*+
Eyes	Gall bladder*+	Pancreas*+
Thyroid*+	Spleen*+	Kidneys*+
Heart*+	Esophagus*+	Adrenals*+
Thymus*	Urinary bladder*+	Intestine*+
Lungs*+	Chest*	Testes*+
Prostate*	Active bone marrow*+	

*Organs in the ICRP103 report for effective dose.
+Organs used on the calculation of the total SPCR in table 12D-1 from the BEIR VII.

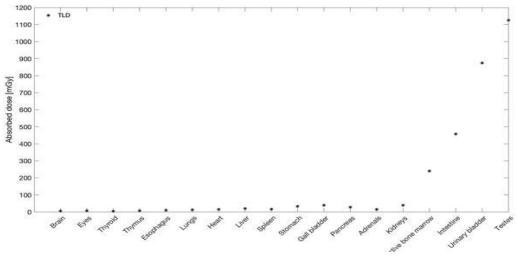

Figure 1: Absorbed dose to organs in CBCT for IGRT prostate cancer radiotherapy.

Conclusion: The use of the pelvis scanner protocol, with 42-fractions, resulted in dose to organs (except testes) of less than 1 Gy. Dose to the prostate gland by IGRT might justify not being ignored during the planning and delivery of the treatment. The calculated effective dose resulted equivalent to approximately 25 whole-body CT scans or more than 60 diagnostic pelvic CTs. BSN acknowledges the essential support of Conicyt (Fondecyt N118113)