**Assessment of doses made during imaging procedures of the technical platform of the Lorraine Cancer Institute (ICL)**

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**Introduction:**

With the development of image-guided radiotherapy treatment techniques (IGRT), the problematic of the number of images and the associated cumulative dose is an important issue.

The goal of this study was to quantify the dosimetric impact of three imaging systems: Clinac (Varian), Cyberknife G4 (CK) and Tomotherapy (Accuray) in realistic treatment conditions.

**Material and method:**

For the Clinac, the dose was measured using thermoluminescent dosimeters (TLD) on the Alderson Rando anthropomorphic phantom (Rando) and on the CTDIw phantom used in CT. For the CK, the measurements were performed on and into the Rando with TLD and a semiconductor kV Unfors Xi sonde (Raysafe).

For Tomotherapy, the Rando and the Cheese phantom were used with TLD and an ionization chamber (A1 SL, Tomoelectrometer, Standard Imaging).

TLD700 (Harshaw) were read with a 2000D reader (Harshaw). Calibration was performed in a 6 MV beam (Clinac).

Dose CBCT measurements were performed at the center of the phantom for three locations: skull (100 kV, 145 mAs, 365 projections), pelvis (125 kV, 680 mAs, 665 projections) and thorax (110 kV, 262 mAs, 655 projections).

The dose in CK were measured at the entrance kV imaging beam and at OAR locations (chiasm, optic nerves, lung, femoral heads). Acquisition parameters are: 120 kV, 150 mAs, 100 ms. Given the expected low dose, measurements are cumulated over 100 expositions.

For Tomotherapy, measurements were made on the Rando at different OAR locations, with a 3 mm slice thickness. The estimations of the dose to the OAR for 1 and 2 mm slice thicknesses were obtained using the ratio of measurements made at the Cheese phantom center for 1, 2 and 3 mm slice thicknesses.

The dose estimations over the whole treatment were based on 30 acquisitions for CBCT and MVCT and 300 (150 pairs) for CyberKnife.

**Results:**

The measured doses to OAR for one acquisition and the estimated dose to OAR throughout the whole treatment are presented in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | Dose per image (cGy) | Total Dose (cGy) |
| CBCT | Skull | 0.42 | 12.60 |
| Pelvis | 3.00 | 90.00 |
| Thorax | 0.94 | 28.20 |
| CyberKnife | Skin | 0.09 | 13.50 |
| Chiasm | 0.06 | 9.00 |
| Optic nerves | 0.05 | 7.50 |
| Lungs | 0.08 | 12.00 |
| Femoral heads | 0.04 | 6.00 |
| MVCT | Chiasm | 3 mm slice | 1.23 | 36.90 |
| 2 mm slice | 1.73 | 51.90 |
| 1 mm slice | 3.64 | 109.20 |
| Spinal cord | 3 mm slice | 1.21 | 36.30 |
| 2 mm slice | 1.71 | 51.30 |
| 1 mm slice | 3.58 | 107.40 |
| Lung | 3 mm slice | 1.09 | 32.70 |
| 2 mm slice | 1.54 | 46.20 |
| 1 mm slice | 3.23 | 96.90 |
| Femoral heads | 3 mm slice | 1.10 | 33.00 |
| 2 mm slice | 1.55 | 46.50 |
| 1 mm slice | 3.26 | 97.80 |

**Discussion and conclusion:**

The optimization of CBCT protocols on Varian systems allows daily IGRT without exceeding a delivered dose of 1 Gy for the whole treatment, threshold from which no action is taken in the ICL service. For the CK, the skin dose provided by the tracking images is less than 0.15 Gy for the whole treatment. In Tomotherapy, the dose provided by the MVCT with a 3 mm slice thickness remains below 0.40 Gy. In comparison with the 3 mm acquisition, using a 2 mm and 1 mm slice thicknesses increase the dose to OAR by a factor of 1.41 and 2.96 respectively and the delivered dose in IGRT can exceed 1 Gy for a 1 mm slice thickness.