Independent Remote audits for TG-51 Non-Compliant Photon Beams Performed by the IROC Houston QA Center

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Introduction

The Imaging and Radiation Oncology Core Houston Quality Assurance Center (IROC-H) conducts external audits for output check verification of photon and electron beams on an annual base. The program is based on mailable detectors and miniphantoms. Many of the beams checked can meet the geometric requirements of the TG-51 calibration protocol. Those beams that do not meet the requirements are called TG-51 non-compliant beams. Examples that are evaluated in this work are Elekta GammaKnife, Accuray CyberKnife and TomoTherapy units. IROC-H has designed specific audit tools to monitor the reference calibration of these units.

Methods and Material

IROC-H used TLD-100 powder in capsules and Harshaw 3500 readers as well as OSLD nanodots and Microstar readers for the remote monitoring program to verify the output of machines with TG-51 non-compliant beams. Acrylic mini-phantoms holding OSLD nanodots are used for the CyberKnife. Special phantoms holding encapsulated TLD powder are used for TomoTherapy and GammaKnife machines to accommodate the specific geometry of each machine. These remote audit tools are sent to institutions to be irradiated and returned to IROC-H for analysis.

The miniphantom used for a Cyberknife unit is an acrylic block of 3 cm water equivalent thickness and 2 nanodots located in its center. The acrylic phantom used for a TomoTherapy unit has a cylindrical shape with a water equivalent radius equal to d_{max} (1.5 cm). TLD capsules are located in the center of the cylinder. This device allows the verification of the output in the rotational beam. The cassette used for the output verification for a GammaKnife unit can be inserted in the Elekta QA sphere. TLD capsules are located in the center of the cassette.

The dose level is 6 Gy for the TLD system (TomoTherapy and Gammaknife) and 1 Gy for the OSLD system (Cyberknife).

Methods and Material (cont'd)

The calculation of dose is based the readings from the detectors, calibration of the system based of a reference dose and energy (3 Gy and ^{60}Co, respectively) and corrections factors to take into account changes in the signal because of dose level, energy, fading and irradiation geometries. Dose calculations are performed using the IROC-H database.

Results

The average IROC-H/institution ratios for 480 GammaKnife, 660 CyberKnife and 907 rotational TomoTherapy beams are 1.000±0.021, 1.008±0.019, 0.974±0.023, respectively.

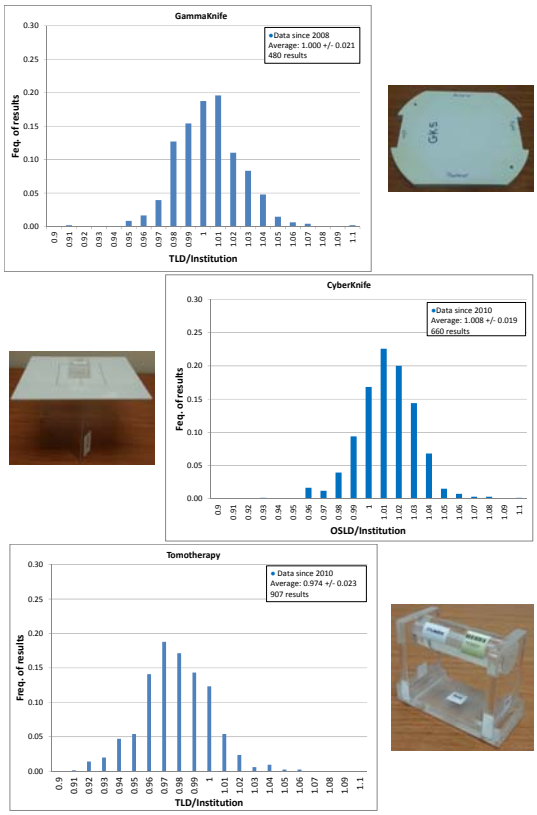

Figure 1: Histograms of results for the different units. Phantoms for each modality are also shown

Results (cont'd)

These ratios have shown some changes compared to values presented in 2008. The GammaKnife results were corrected by an experimental determined scatter factor of 1.025 in 2013.

There are no changes in the evaluation of irradiation on Cyberknife.

The TomoTherapy results are now only from a rotational beam whereas in 2008 the results were from static beams only. The decision to change from static to a rotational modality was based on recommendations from the users. The average ratio was evaluated under different conditions. The results presented in figure 1 are for all units (HiArt and HD) and the overall ratio for HD units is 0.977±0.022. The average for the checks done during 2015 has increased by almost 1% compared to historical values.

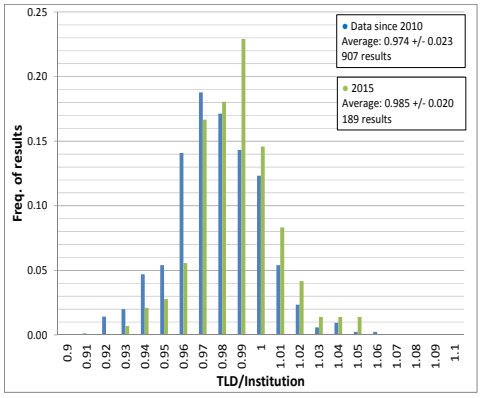

Figure 2: Evaluation of the results for TomoTherapy

The standard deviations of all results are consistent with values determined for TG-51 compliant photon beams.

Conclusions

External audits of beam outputs is a valuable tool to confirm the calibrations of photon beams regardless whether the machine is TG-51 or TG 51 non-compliant. The difference found for TomoTherapy units is under investigation.

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