Peripheral Patient Dose Measurements for IMRT Delivered with Helical Tomotherapy and Linac

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Purpose/Objective(s): To estimate peripheral doses (PD) to the healthy tissues outside the treated region for intensity-modulated radiotherapy (IMRT) delivered with helical Tomotherapy (HT) and linac with dynamic multileaf collimator (dMLC).

The PD is a result of the increased x-ray leakage radiation to the patient due to the longer beam-on times associated with IMRT. The increasing use of IMRT has focused attention on the need to account for PD because of increasing probability of secondary malignancies. It was attempted in this study to measure the PD for IMRT patients.

Materials/Methods: On Trilogy linac (Varian) and HT, both with 6 MV photons, 20 patients each were randomly selected for this study. Radiotherapy plans were generated with the Eclipse (Varian) and with the Tomoplan planning system. Measurements of PD were done with the help of thermoluminescent dosimeters (TLD: LiF:MgTi) and Semi Conductor Diodes (DPD-12) along the longitudinal axis of the patient outside the primary beam at different distances (5 cm interval upto to 25 cm) from the edge of the planning target volume (PTV). Diodes and TLDs (for low dose sensitivity) were calibrated in Linac and HT prior to the measurements. TLDs were irradiated for ten consecutive fractions considering the sensitivity of the detector. Diodes were kept at 10 cm and 20 cm from the field edge. Measurements with diodes were performed for four consecutive days to estimate the reproducibility. The measurements included daily cone-beam computed tomography (CBCT).

Results: All PD values were normalized to the median dose of the PTV. The PD values decrease almost exponentially with increasing distance from the field edge. The PD for Linac was in a range of 6.55% (at 5 cm from field edge) near the primary dose region to 0.45% (at 25 cm) far from the primary dose region. Similarly for HT, the PD values at above distances, ranged from 4.94% to 0.1%. Linac showed mean PD as 2.44% (10 cm while Tomotherapy PD as 1.02%. The PD is nearly equal at a distance of 25 cm from the edge of the PTV. The PD for HT was found lower (by factor of 2) than that for dMLC. Mean PD estimated with Diode for Linac is about 1.4% and 0.32% at 10 cm and 20 cm respectively. The results obtained with TLDs were in well agreement with the other studies. Diodes underestimated the PD when compared to TLDs which needs further investigations.

Conclusions: The peripheral dose with Linac is higher compared to HT. This may be due to the divergent beam of Linac compared to the fan beam of HT. Another reason could be the leakage from Linac MLC (2%) compared to HT MLC (0.3%).