

Purpose: To determine the dosimetric uncertainty of MVCT images obtained with a helical TomoTherapy unit for use in adaptive radiotherapy evaluations.

Methods: A water, head, and thorax phantom were used to quantify the baseline uncertainty in dose recomputations. Each phantom was planned and then re-imaged using helical MVCT. Dose was recalculated on the MVCT images and compared to the plan DVHs for each target. Next, the variation of the MVCT images over three years on two machines was assessed. MVCT images of the TomoTherapy CT density calibration phantom were analyzed to find the variation in the solid water CT number over this time. To quantify the dosimetric changes resulting from this temporal variability, dosimetric endpoints were compared versus solid water CT number changes for an oropharynx patient.

Results: The D95, D50, and D05 dosimetric endpoints were compared for each phantom in the baseline evaluation. D50 deviated by -0.4%, -1.3%, and 0.7% from the planned dose for the water, head, and thorax phantoms, respectively. The solid water CT number varied, over time, from a maximum of 108 HU to a minimum of -3 HU. This translated into a total dosimetric variation in the D50 of the oropharynx patient's PTV of 2.9% (-1.7% to +1.2%). The parotids varied less than the target with a total D50 variation of 1.5% and 1.2% for the right and left parotids, respectively.

Conclusions: This work suggests that the observed temporal variation of the MVCT number alone does not translate into dosimetric discrepancies greater than 3%. Maintaining the solid water MVCT number within 30 HU of its calibrated value should be sufficient to achieve dose recalculation results within 2.5% of the expected values, including the baseline error.

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