Can We Ignore Angular Acceleration and Deceleration Caused by Gantry Angular Speed Modulation in Volumetric Modulated Radiation Therapy

Objective: VMAT optimizes both MLC apertures and MU weights simultaneously. Additionally, VMAT uses a substantially higher gantry angle sampling frequency than DAO to better model the continuously moving source. VMAT achieves a desirable intensity modulation through a synergistic combination of MLC aperture, dose rate, and gantry angular speed modulations. Unlike conventional rotational techniques, VMAT requires the gantry to accelerate and decelerate frequently to deliver a given angular dose rate (MU/degree). This could potentially become a source of dosimetric error. In this study, we investigated the potential dosimetric effects of gantry angular acceleration and deceleration in VMAT delivery.

Materials and Methods: A commercial phantom, MapPHAN with MapCHECK, was scanned on a CT scanner with a slice thickness of 3 mm and a matrix size of 512×512. The acquired CT images were transferred to our in-house VMAT TPS for treatment planning. A VMAT plan with 180 control points and 360° gantry rotation was computed. On a Varian Trilogy CLINAC, the VMAT plan was delivered to the phantom six times with six different maximum dose rates: 600, 500, 400, 300, 200, and 100 MU/min, respectively. The measured dose distribution with 600 MU/min was used as the baseline for comparison purpose**.**

Results: We found that there were observable dose differences in the dose map between the measured dose distributions for 600 MU/min and 100 MU/min. These dose discrepancies covered an extensive area, but were mainly concentrated in the PTV, i.e., in the high dose and high dose gradient regions. The dose differences ranged from -2 ~ 6 cGy.

Conclusions: For a few fractions, this difference may be trivial. But for dose escalation cases, the accumulative dose differences could be significant and should not be ignored.