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Abstract

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Dosimetric Case Study of Simultaneous and versus Sequential Treatment Delivery with Different Isocenter Strategies for Geographically Approximated Oligometastatic Lesions

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Abstract

Objective: LINAC-based stereotactic body radiotherapy (SBRT) has gained popularity in treating oligometastases from malignancies like prostate cancer. This study aims to compare dosimetric outcomes of different SBRT methods: simultaneous treatment of multiple metastases versus sequential delivery with different isocenter strategies.

Methods: There are three metastases (two pelvis and one osseous) from prostate cancer within close proximity of each other. PTV volumes are 4.6 cc, 6.0cc and 8.2cc. The distances between tumors range from 2cm to 4.2 cm. A total dose of 35 Gry in 5 fractions were prescribed to all three tumors per protocol. Multi-partial VMAT arcs from Eclipse and Element Dynamic Conformal Arcs plans were implemented for these three tumors using one isocenter and three separate isocenters on the Varian Truebeam machine with 6X FFF beam: One ISO Brainlab Elements plan (dyn.1ISO), one ISO VMAT plan (VMAT.1ISO) and three ISO VMAT plan (VMAT.3ISO). Dose constraints were used for plan evaluation for the organ at risks (OARs) close to the targets: Jejunum-ileum, SacralPlexus, Bladder, Colon, CaudaEquina, Rectum, Skin, and Femoral Head.

Results: For all SBRT plans, the PTV coverages were equal, with 95% of the PTV volume covered by 100% of the prescribed dose. Dyn.1ISO's OAR's Dmax is 10.1% less than for VMAT.3ISO. VMAT.1ISO's OAR's Dmax is 14.0% less than in VMAT.3ISO. VMAT.1ISO's Dmax is 4.3% less than dyn.1ISO, which is reflected in the higher average OAR dose in VMAT.1ISO. The gradient index of VMAT.1ISO is 25.4% higher than in dyn.1ISO, and the monitored units (MU) required by dyn.1ISO's MU is 58.5% less than required in VMAT.3ISO. VMAT.1ISO also requires 45.3% less MU than in VMAT.3ISO. Conformity of these three plans are comparable (within 6%). All three plans met pre-determined dose constraints.

Conclusion: This study showed that dyn.1ISO, VMAT.1ISO and VMAT.3ISO provide comparable SBRT plans. VMAT plans provide better conformal plans with higher optimization options but require higher MU to achieve it. One isocenter plans require less MU compared to plans with three separate isocenters. However, the plan with three isocenters provides the oncologists with the option to perform sequential treatment as opposed to simultaneous treatment.