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# A Quantitative Interplay Effect Analysis for IMPT in Lung Cancer SBRT Between Two Different Machine Delivery Sequence Models

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## Abstract

Objectives:

To quantitatively investigate the interplay effect between two different machine delivery sequence models: IBA ProtuesONE (a synchrocyclotron accelerator system pulsed beam extraction) and the ProtuesPlus (a cyclotron accelerator system with a continuous beam extraction). The goal is to assess differences in plan quality for lung cancer stereotactic body radiotherapy (SBRT).

Methods:

An interplay evaluation tool was developed to integrate 4D CT data and two validated machine delivery sequence models, IBA ProteusONE and IBA ProteusPlus . The simulation is based on the patient breathing cycle 5 seconds. Five lung cancer SBRT cases planned with Intensity-modulated proton therapy (IMPT) were retrospectively selected. The dosimetric metrics of the target: D99%, D1%, Homogeneity Index (HI), and Conformity Index (CI) were used to evaluate the interplay effect quantitatively. Additionally, the effective beam on time (includes spot irradiation time, spot switch time and burst switch time) and static delivery time were also compared across the two machine delivery sequence models.

Results:

With the same nominal plan, the IBA ProteusONE showed a mean CTV D99% degradation of 1.83%, while the IBA ProteusPlus exhibited a larger target coverage degradation of 3.61%. For CTV D1%, the IBA ProteusONE increased by 3.01% compared to 5.11% if using IBA ProteusPlus system. The IBA ProteusONE model had a smaller decrease in HI (-0.05) than the IBA ProteusPlus (-0.116). Similarly, the CI decreased by 0.02 for the IBA ProteusONE model and 0.014 for the IBA ProteusPlus model. The IBA ProteusONE effective beam-on time is about 45.55 seconds, significantly longer than the 11.66 seconds for the IBA ProteusPlus. Static delivery times were also longer for the IBA ProteusONE model (70.23 s) compared to the IBA ProteusPlus (41.91 s).

Conclusion(s):

The interplay effect varies between the two proton systems equipped with different accelerators in lung cancer SBRT. The IBA ProteusONE offers better target dose “robustness” but at the cost of longer effective beam on time and delivery time compared to the IBA ProteusPlus system.