Evaluation of a prototype treatment planning system (TPS) for biology-guided radiotherapy (BgRT) in the context of stereotactic body radiation therapy (SBRT) for oligo-metastases

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Purpose/Objectives:

BgRT is currently being developed to utilize PET emission data to guide radiotherapy delivery in real-time to multiple targets. The system combines a compact 6MV linear accelerator and binary multileaf collimator with PET, CT and MV imaging systems all on a ring gantry that rotates continuously at 60 RPM while the patient is translated through the system bore. Here we investigate the feasibility and dosimetric benefits of a prototype TPS for BgRT using a single isocenter technique for oligo-metastases patients treated with SBRT.

Materials/Methods:

Included in this study are five oligo-metastatic patients who are treated with SBRT combined with immunotherapy under an IRB protocol. Except for one patient, all had two peripheral lung lesions treated to a total dose of 45Gy (15Gyx3). The last patient had four oligo-metastases including lung (15Gyx3), mediastinum (10Gyx5), liver (15Gyx3) and para-spinal (10 Gyx3). Except for one patient, all were treated with a multiple isocenter technique using 3D, volumetric arc therapy (VMAT) or intensity modulated radiation therapy (IMRT) depending on size and location of target. All five patients were re-planned with the prototype TPS currently under development using a single isocenter technique without using PET-guidance. Prototype TPS plans were normalized to achieve the same clinical target coverage level (+/- 2.5%). The 3D dose distributions and dose volume histograms (DVH) for all targets and organs at risks (OAR) were compared between the clinical and prototype TPS plans.

Results:

Prototype TPS improved the dose to normal lung compared to other planning techniques delivering on average 16.2% and 6.6% less dose at 20 and 11 Gy levels, respectively. The $D_{0.03cc}$ of heart, esophagus, spinal cord, trachea/bronchus, skin and great vessels were all within acceptable protocol dose limits and were comparable between the prototype TPS and clinical plans. The dose coverage for all targets was within 2.3% of the clinical plans. The prototype TPS plans showed higher dose within the PTV; the volume receiving 110% or greater inside PTVs was on average 3.3 times larger in prototype TPS plans.

Conclusion:

SBRT for oligo-metastasis has been shown to improve outcome in select patients; however, the number of lesions that can be treated efficiently in the clinic is currently limited. The single isocenter treatment technique as implemented in the prototype TPS has the potential to improve planning efficiency, critical organ sparing, and delivery making treatment of multiple lesions clinically feasible. Further studies need to be directed to dose verification and efficiency of planning and delivery.