Generalizable Class Solutions for Treatment Planning of Spinal Stereotactic Body Radiation Therapy Cases

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Purpose/Objective(s): Stereotactic Body Radiotherapy (SBRT) is a non-invasive treatment for spinal metastases which achieves a high probability of local control by conformal administration of hypofractionated radiation with submillimeter precision. Spinal SBRT is resource intensive, posing unique challenges for reproducible and efficient treatment planning. The time required to generate an optimal treatment plan can be extensive, with a substantial learning curve for novice planners - an obstacle to widespread clinical adoption and application in urgent clinical scenarios. Additionally, given the target’s proximity to a critical dose-limiting structure, planning can be hindered by uncertainty that a given treatment plan represents the best achievable coverage within anatomic and treatment delivery constraints.

Thus, we sought to develop a generalizable class solution approach for spinal SBRT which would reduce integral dose, maximize planning efficiency and allow confidence that a given plan provides optimal target coverage.

Materials/Methods: We examined 91 spinal SBRT patients treated at our institution from 2005-2009. Patients were typically treated with 27 Gy in 3 fractions, or 16-24 Gy in 1 fraction. Treatment plans were categorized by lesion location, CTV shape, and dose fractionation scheme, and analyzed to determine the technically achievable dose gradient (Gy/mm between the prescription isodose line and the spinal cord tolerance isodose line). A lookup table was generated to yield a radial cord expansion, which is subtracted from the CTV to yield a planning CTV (pCTV) construct for evaluation.

Results: We reviewed target coverage, dose gradient, conformality, and maximum cord dose to select the best plans in each category for further analyses (e.g. beam angles, optimization parameters, and planning structures). Multiple solutions were incorporated into a set of class solutions and tested for reproducibility and quality. For each category of spine tumor configuration, selected plans were re-optimized using the class solutions, and compared to the original set of plans created from scratch. The class solution technique generated plans which improved conformality (1.2 fold increase in the 95% Conformation Number), while reducing integral dose (1.3 fold decrease in V4Gy) and machine output (19% MU reduction). The maximum dose (dmax) to 0.01 cc of spinal cord was slightly (~5%) reduced and target coverage was on average unchanged.

Conclusions: We have developed a set of IMRT class solutions for spinal SBRT which yield dosimetrically superior treatment plans according to criteria of conformality, integral dose, total monitor units, spinal cord dmax, and target coverage regardless of planner experience.