AbstractID: 3478 Title: A computer model for automatic planning and optimization for Gamma Knife radiosurgery using auto-positioning system

Purpose: This research addresses the automatic-planning of Gamma Knife radiosurgery using auto-positioning system (APS). We previously reported a morphology-guided automatic planning model via optimization of dose conformity and minimization of total number of shots with different collimator sizes. In this work, our goal is to develop an optimization model that is adaptive to APS by using shots with same collimator.

Method and Materials: Our three-step optimization strategy is: (1) configure the initial shot set using a combined process of skeletonization and bin-covering, (2) optimize the relative weight (exposure time) of each shot to improve target coverage while minimizing normal tissue toxicity, and (3) fine-tune the shot configuration by adjusting shot locations, and adding or deleting shots to further improve the balance between target coverage and normal tissue toxicity. In the weight optimization phase in step 2, an easy-to-solve linear fractional program explicitly models the dual objectives and takes into account of dose-renormalization (i.e., maximum is always renormalized to 100%). The fine-tuning step explicitly takes into account of shot overlapping, dose renormalization and target shape thus making the tracking of hot spots and estimating the effects of shot movement, addition and/or deletion possible.

Results: We have implemented this optimization model on the Windows-based platform and have tested it with seven previously treated clinical cases. The target volume ranges from 2.6 to 8.6 cc, while the number of shots used ranges from 13 to 39. Our computer model generates plans in 1-2 minutes, with compatible quality of physician's plans normally created in 1-4 hours. The target coverage is greater than 95% and PITV ranges from 1.29 to 2.26.

Conclusions: Our computer model can be used for real-time planning, or for generating an initial plan followed by interactive optimization/fine-tuning, or for creating multiple plans with different trade-off objectives.

Conflict of Interest: none

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