AbstractID: 7346 Title: Dose Convolution Filter: Incorporating Spatial Dose Information into Tissue Response Modeling

Purpose: Radiotherapy treatment planning commonly involves analysis of static dose distributions and corresponding Dose Volume Histograms (DVHs). However, such analysis does not account for biological effects of spatial variations in the physical dose distribution. We introduce the Dose Convolution Filter (DCF) model capable of incorporating spatial dose information in plan analysis and optimization, and integrating biological factors such as cell migration and bystander effects into physical dose distributions. The DCF model should allow more accurate prediction of tissue response from complex radiotherapy dose distributions, and can facilitate modeling of the effects of patient motion.

Method and Materials: We use a Gaussian convolution filter with standard deviation, σ, determining the degree of dose washout. To test this model, filtered dose distributions are applied to a NTCP model to calculate tissue response. As an illustration, we determine σ from existing rat spinal cord data, and compare model-predicted NTCP with published data. We also simulate the GRID technique, in which an open field is collimated into many pencil beams.

Results: After applying DCF, an NTCP model can predict dependence of tissue response on variations in spatial dose distribution. The model successfully fits the rat spinal cord data with a predicted value of $\sigma=2.6\pm0.5$mm, consistent with 2mm migration distances of remyelinating cells. Moreover, it enables the correct prediction of a high relative seriality for spinal cord. Finally, this model also predicts the sparing of normal tissues by the GRID technique when the size of each pencil beam becomes comparable to σ.

Conclusion: The DCF model incorporates spatial dose information and offers an improved way to estimate tissue response from complex radiotherapy dose distributions. It does not alter the prediction of tissue response in large homogenous fields, but successfully predicts increased tissue tolerance in small or highly non-uniform fields.

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