AbstractID: 3909 Title: Optimization of basis function sets to represent IMRT intensity patterns in inverse planning

Purpose: To investigate the use of mathematical basis functions instead of discrete or smoothed beamlets to represent and optimize IMRT beams in inverse planning in order to reduce the degrees of freedom required for producing high quality IMRT plans.

Methods and Materials: Our in-house beamlet-based optimization system was extended to support the optimization of basis function coefficients in order to represent IMRT beams by mathematical surfaces. Comparison studies were performed using a phantom and a prostate case. Four methods were compared; (1) beamlet optimization, (2) beamlet optimization incorporating smoothing in the cost function, (3) Basis function optimization (BFO) using a radial basis function grid (optimization variables are individual function weights), and (4) BFO using polynomials (optimization variables are term coefficients). Results were compared using dose and dose-volume metrics, beam modulation, MU, and robustness to geometric deviations.

Results: In the phantom, BFO plans were comparable to beamlet plans in terms of dose and dose-volume metrics and superior in terms of using 75-90% fewer optimization variables, requiring 26% fewer MU, containing 38% less plan modulation, and demonstrating improved target coverage when subjected to geometric shifts. Beamlet-based plans that incorporated smoothing met the clinical objectives, with a 16% reduction in MU compared to beamlets. In the prostate, method (3) resulted in a 24% MU reduction compared to method (1) and was less sensitive to geometric changes. Method (2) also produced favorable results in the prostate with a 19% reduction in MU.

Conclusion: BFO plans were clinically comparable to beamlet plans and superior to beamlet plans with smoothing in terms of MU reduction and lessened geometric sensitivity. The use of basis function sets to represent and optimize IMRT intensity patterns is a promising method to reduce IMRT beam complexity and its implications.

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