The effects of beamlet size on IMRT optimization

Intensity modulated radiation therapy (IMRT) has been implemented using multileaf collimators (MLCs) whose leaves project to a 1-cm width at isocenter using a 1-cm step size for a “step-and-shoot” leaf sequence. This study explored the clinical usefulness of smaller beamlet sizes for IMRT produced by smaller step sizes and thinner leaf widths. IMRT treatment plans were computed for two clinical cases. The first case was in the cranium close to the orbits, the optic nerves, the optic chiasm, and the brain stem. A prostate cancer site was chosen for the second case, for which bladder and rectum were regarded as the critical organs. Nine equally spaced beam directions were used for these plans. The effects of step sizes of 10mm, 5mm, and 2mm for a 10-mm wide MLC leaf were analyzed, while no changes to the input parameters were made. The computation was repeated for 15-MV, 6-MV and 4-MV photon beams in order to investigate energy dependencies. Dose volume histogram (DVH) analysis showed that smaller beamlets generated superior target coverage for both the cranial and the prostate cases. There were no distinct energy dependencies. However, the protection of normal tissue exposure appeared to depend on other factors as well. These results support the intuitive notion that smaller beamlets associated with thinner MLC leaf widths and smaller step sizes will for the most part produce superior optimized IMRT treatment planning results.

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