The current treatment planning strategies for MLC-based IMRT involve a two step process. First, an optimization algorithm produces the optimum intensity pattern for each beam direction. Next, a leaf-sequencing algorithm translates each pattern into a set of deliverable aperture shapes. Because the leaf-sequencing is constrained by the delivery hardware, a large number of complex field shapes are often needed. This can lead to a loss in efficiency and an increase in collimator artifacts.

We have developed a system that directly optimizes aperture shapes for step and shoot IMRT. The key simplification offered by this system is that the user can specify the maximum number of allowable beam segments as part of the prescription. Because only deliverable MLC shapes are used in the optimization, we expect a considerable reduction in the complexity of IMRT deliveries.

The treatment plan goals are defined in the form of a dose volume histogram. The leaf positions are optimized using a simulated annealing algorithm while the aperture intensities are simultaneously optimized using iterative least squares minimization.

We have tested this approach using 3D Monte Carlo computed pencil beams incident on a cylindrical phantom. The results indicate that direct aperture optimization can produce highly conformal step-and-shoot treatment plans using only three to five apertures per beam direction. The reduction in the number of field segments can be expected to increase efficiency of IMRT deliveries without sacrificing dose conformity.

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