AbstractID: 2975 Title: An Analysis of Intensity Discretization Errors in IMRT

Purpose

A simple analysis is presented of the deviation in dose when intensity is converted from continuous to discrete levels. This analysis assumes that intensity levels are equally likely and beams are discretized independently.

Methods and Materials

If there are ***i*** non-zero intensity levels possible then the standard error due to discretization for a single beam direction is just equal to:

$$\boldsymbol{\varepsilon} = \frac{\mathbf{1}}{\sqrt{\mathbf{12}\,\boldsymbol{i}}} \qquad \text{Eqn. 1}$$

There are situations in multiple beam delivery where one beam direction dominates the dose to a voxel. In this case, the accuracy that can be delivered to that voxel is going to be dependent only on the graininess of the discretization and Eqn. 1 also applies. For the case of beam direction independence, the standard error to be expected in the dose distribution for ***N*** beam directions is given by:

$$\boldsymbol{\varepsilon} = \frac{\mathbf{1}}{\sqrt{\mathbf{12}\,\boldsymbol{i}}\sqrt{\boldsymbol{N}}} \qquad \text{Eqn. 2}$$

Results

For the case of 5 intensity levels, dominated by a single beam, the standard error to be expected is 5.8% according to Eqn. 1. For the case of 5 intensity levels and 5 roughly equally contributing beam directions, the standard error to be expected is about 2.2% from Eqn. 2. The standard error to be expected for a tomotherapy dose distribution with 50 intensity levels is about 0.58% when one beam direction from one rotation is dominant (using Eqn. 1). Using Eqn. 2 the standard error is 0.04% for 50 levels when beams from 51 directions and 4 rotations (i.e., pitch 0.25) contribute equally to each voxel.

Conclusions

Equations 1 or 2 represent upper and lower limits, respectively, of the standard error due to discretization. Finer discretization and more beams reduce error, but there is more to be gained in increasing intensity levels than in increasing the number of beam directions.

Conflict of Interest

This work was supported by TomoTherapy Inc.