A Feasibility Study For Tomotherapy Beam Delivery

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To achieve optimal treatment planning, beam delivery and treatment verification, a new concept known as "tomotherapy" has been proposed by Mackie et al. In this approach, a narrow slit beam moves around a tumor in a helical fashion. Intensity modulation as predicted by an inverse treatment planning system can be used to achieve a highly conformal uniform dose distribution for an arbitrarily shaped target. This cannot be achieved by the current state-of-the-art technology.

This thesis research studied the feasibility of such a machine. A computer controlled phantom positioning device was developed to enable the simulation of the tomotherapy helical beam delivery. Artifacts such as arising from indexing errors and patient motion were also studied. Two methods were developed to deliver optimally planned, intensity modulated beams. The feasibility of using a Monte Carlo method for virtual simulation os a tomotherapy linac treatment head was also explored.

The results showed that the helical beam can be delivered with desirable dosimetric characteristics, including eliminating the indexing error. With the right combinations of beam width and rotation speed, tomotherapy also can minimize the effects of breath motions to the dose distributions. With an intensity modulator, the highly conformed dose distribution predicted by "inverse planning" can be delivered with satisfaction. Small deviations exist due to the approximations used in the methods, but they delivered far superior dose distributions that conventional technology.

The study also shows that Monte Carlo simulations can be used for accurate calculations of characteristics of the tomotherapy beam. Improvement of treatment head design can be made on the basis of these simulations.