AbstractID: 7613 Title: Determining

Purpose:

Respiratory gated irradiation offers potential for margin reduction and dose escalation for treating moving tumors in the thorax or abdomen. Unfortunately, for synchrotron-based proton irradiation, it may not be efficient. We have determined the optimal respiratory gating parameters for passively scattered proton irradiation on a synchrotron through a simulation study.

Method and Materials:

An in-house software program was developed to investigate the interaction of the respiratory gating intervals with different synchrotron magnet excitation cycle patterns. Test data was obtained by using the recorded respiratory trace of 94 patients who underwent 4DCT. A typical magnet excitation cycle, T_{cyc} consists of proton acceleration, flat top and deceleration periods. Proton beam delivery occurs only during the flat top portion of each such excitation cycle. Respiratory gating was simulated at expiration for a 30% duty cycle around peak exhalation. The time required to deliver 100 MUs was estimated for the following scenarios: (a) Ungated irradiation with T_{cyc} set to the minimum value (2.7sec) and (b) Gated irradiation with T_{cyc} set to (i) the minimum value, (ii) approximately equal each patient's average respiratory cycle, and (iii) a variable value according to each individual respiratory cycle. Overall treatment time and efficiency of treatment delivery were studied in each case.

Results:

Average times required to deliver 100 MUs were 1.1 minutes for ungated irradiation; and 3.7 (1.7 - 6.0), 3.2 (1.6 - 7.1), 2.3 (1.4 - 3.1) minutes respectively for gated irradiations at various scenarios mentioned above. For gated irradiation, variable T_{cyc} mode of operation yielded least overall treatment time and greatest efficiency of proton beam delivery.

Conclusion:

Respiratory gated passively scattered proton delivery using a synchrotron-based system is feasible without significantly increasing treatment time. Based on above results, variable T_{cyc} mode of operation offered least overall treatment time and greatest efficiency for respiratory gated irradiation.