AbstractID: 11600 Title: Efficiency of respiratory-gated synchrotron based scanning beam delivery of proton therapy for lung

Purpose:

To quantify the efficiency of respiratory-gated synchrotron based scanning beam delivery of proton irradiation for lung tumors.

Method and Materials:

An in-house software program was developed to simulate the interaction of the respiratory-gate signal based on respiratory traces of patients from an external respiratory monitor and the synchrotron magnet operation pattern in scanning beam proton delivery. A simulation study was performed using 10 proton scanning beam plans (total 33 beam angles) for lung tumors. For each plan, 10 patient breathing traces were used to simulate respiratory gated delivery. The total time to deliver each beam was determined for non-gated and gated modes (30%, 20% and 10 % duty cycles respectively). Efficiency was determined using the effective dose rate (MU/min). The relationship between effective dose rate with and without gating was examined for different irradiated volumes along each beam direction and the number of control points in each plan.

Results:

The average effective dose rate was 34.2±18.8 (MU/min) for non-gated treatment. This represented an approximately three fold reduction as compared to the passively-scattered proton delivery (90.1 MU/min). With gating, effective dose ratios were further reduced to 13.8±4.7, 9.3±3.6 and 3.7±1.7 MU/min for 30%, 20% and 10 % duty cycles respectively. Using an average MU per beam at 70.9, the estimated treatment delivery time for a single beam was 2.1 min for non-gated treatment, and 5.1, 7.6, and 19.1 min for gated treatment with 30%, 20% and 10 % duty cycles, respectively. No strong relationship was found between the effective dose rate and the irradiated volume or the number of control points.

Conclusion:

Respiratory gated delivery of pulsed scanning beam proton therapy for lung cancer is less efficient than passively-scattered proton irradiation. Further studies are needed to improve delivery efficiency in the treatment plan optimization using patient specific breathing patterns.