AbstractID: 8438 Title: Performance of a beam tracking system for treatment of moving targets with scanned ion beams

Purpose:
Scanned ion beam therapy of intra-fractionally moving targets requires motion mitigation to prevent deteriorations of the delivered doses due to interplay. A beam tracking system was developed and experiments with various detectors were performed to assess system performance.
Method and Materials:
Tracking of moving targets with scanned ion beams requires simultaneous lateral and longitudinal range adaptation of pencil beam positions. Lateral beam tracking is achieved directly with the beam scanning system. Longitudinal tracking is performed with a dedicated energy modulation system consisting of fast, motorized absorber wedges. In experiments with radiographic films, a range telescope, and an array of pin-point ionization chambers in a water phantom, the precision of lateral, longitudinal, and 3D motion compensation was measured. Motion was induced laterally by a sliding table and longitudinally by ramp-shaped absorbers. Motion detection was performed with a laser-triangulation sensor. Experimental tracking data were compared to results of measurements with stationary detector systems. Films were analyzed with respect to geometrical shape as well as mean, minimum, and maximum response level within the target region. Ionization chamber data were analyzed for different volumes of the setup. Analysis of range telescope data focused on Bragg-peak shapes and ranges.
Results:
Film analysis yielded conservation of geometrical shape and responses (mean±SD, minimum, maximum) of (0.276±0.010, 0.241, 0.288) and (0.275±0.007, 0.252, 0.284) for stationary irradiation and tracking respectively. Within the target volume, ionization chamber data with beam tracking deviated from stationary irradiation by 0.3 ± 1.5% with -2.7% minimum and 3.7% maximum deviation. The Bragg peak range for tracking deviated by less than 0.25 mm water-equivalent from the stationary reference.
Conclusion:
The tracking system for scanned ion beams successfully restored dose distributions for moving targets by adapting individual Bragg peaks during irradiations in quasi real time.
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