AbstractID: 8536 Title: Dose smearing in GRID therapy due to tumor motion

Purpose: Clinical and biological evidence suggests that GRID therapy is successful in debulking large tumors because of the high heterogeneity in the dose distribution. In this paper we show that the characteristic peaks and valleys are significantly smeared out by motion, possibly affecting clinical outcomes.

Methods: Using a Monte Carlo engine that emulates phantom motion, we calculate dose for a hexagonal GRID, with 1.3 cm wide holes separated by 2.1 cm at isocenter. We study motion in the *z*-direction, parallel to rows of holes, or in the perpendicular *x*-direction. The displacement-time waveform follows a $\cos^n$ pattern, with *n* assigned 1 or 6 to account for a range of inhale-exhale asymmetry. Dose calculations are performed for 6 MV x-rays.

Results: Near d_{max}, the static valley dose is 0.12 D_0, where D_0 is the peak static dose. For a sinusoidal *z*-motion with amplitude *a*, the minimum peak ($D_{p\text{-}min}$) and maximum valley ($D_{v\text{-}max}$) occur at $a \approx 0.8$ cm with values 0.67 D_0 and 0.60 D_0 respectively. As *a* is increased, contributions from neighboring holes make the peaks and valleys vary periodically with *a*. Less degradation is seen with asymmetric $\cos^6$ type motion, with $D_{p\text{-}min}$ = 0.77 D_0 and $D_{v\text{-}max}$= 0.45 D_0. For both waveforms, 0.7 cm amplitude lowers the peaks by 20% of D_0, whereas 0.4 cm amplitude raises the valleys by this amount. The corresponding amplitudes for *x*-motion are 0.7 and 1.3 cm. Thus, motion effects may be alleviated by properly choosing the grid orientation. GRIDs with smaller hole separations yield motion effects at smaller amplitudes.

Conclusion: The results correlate with the clinical finding that tumors in abdominal and thoracic areas respond poorly compared to those in static areas such as skin and head & neck. Thus motion compensation may be necessary to maintain the efficacy of GRID therapy.