AbstractID: 12900 Title: Impact of the fraction size on the efficiency of hypoxia-targeting IMRT treatment.
Single fraction simulation study

Purpose:
To investigate the relative gain in local tumor control that can be achieved by using a heterogeneous dose distribution designed to deliver higher doses of radiation to the hypoxic subvolumes as imaged with non-invasive modalities. Here we are focusing on the single-fraction effect of such heterogeneous doses as opposed to the whole multi-fraction treatment.

Method and Materials:
Starting with a distribution of microvessels representative of tumor tissue and using planar simulation of oxygen diffusion, we created a microscopic 2D model of tumor oxygenation. To simulate targeting hypoxic areas with increased radiation doses, we implemented a continuous adaptive, non-linear modulation scheme where the dose boost derived from the oxygen partial pressure distribution is added to the baseline fraction prescription. Tumor cell radiation response was evaluated using linear-quadratic model taking into account individual cell oxygenation levels. To determine relative effectiveness of a hypoxia-targeting modulation scheme, corresponding tumor cell survival fraction was compared to that of treatments delivering the same average dose to the lesion uniformly.

Results:
For the low-dose range (2-3 Gy fraction) hypoxia-targeting treatments did not perform better than the treatments delivering the same average dose uniformly. That points to the fact that while assuming that normal tissue complications are constant over the two delivery strategies, there is no therapeutic gain from targeting hypoxic volumes alone versus escalating the tumor total dose, at low fraction doses. On the other hand, for higher prescription doses (6-8 Gy fraction and above) the effectiveness of hypoxia-targeting treatment increases.

Conclusion:
The therapeutic gain that can be achieved by targeting hypoxia with increased doses of radiation depends greatly on the size of the radiation dose fraction. Our results indicate that this therapeutic gain would be higher for hypofractionated dose regimens with the dose per fraction exceeding 6 Gy than for conventional treatments utilizing 2Gy fraction.