Exploring the Feasibility and Potential of Spatially Fractionated Radiotherapy for Treating Glioblastoma Multiforme (GBM)

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Objectives: Recent experience with multi-metastasis stereotactic radiotherapy and the rise of SFRT suggest that a highly-heterogenous dose distribution may be more effective and tolerable for larger cranial targets than conventional radiotherapy. Recurrent GBM patients suffer from high rates of toxicity and often are not able to tolerate a tumoricidal dose using conventional RT alone. A more effective dose could be delivered and better tolerated using an SFRT technique as an upfront boost for conventional RT. This study explores the feasibility of planning SFRT for recurrent GBM patients, leveraging its strengths of selective killing and sparing, immune response stimulation, and selective vascular disruption.

Methods: We have performed a retrospective dosimetric study simulating the feasibility of performing SFRT in the context of recurrent GBM patients. A cohort of patients who have previously received conventional RT for recurrent GBM at our institution were replanned using SFRT (Lattice therapy technique). SFRT vertices were placed within the high-risk CTV and areas at risk for clinical spread of disease. Cerebral organs at risk (OARs) and regions of normal vasculature were excluded from vertex placement. SRT-level peak dose was optimized to focus on vertices only. BED to the OARs, such as normal brain, brainstem and chiasm etc. were analyzed and compared to conventional radiotherapy.

Results: Preliminary planning results have demonstrated that clinically-acceptable SFRT plans can be achieved with a vertex size of 1-2 cm diameter and spacing between vertices of 2-3 cm. Nearby OAR and normal brain sparing was improved with SFRT compared with conventional RT. Integral dose to brain was reduced with SFRT while delivering SRT-level doses to the high-dose vertices. Peak-to-valley ratios >3 were consistently achieved.

Conclusion(s): Our preliminary study has shown the feasibility of producing deliverable SFRT that can be combined with conventional RT to deliver a potentially tumoricidal dose to the high-risk CTV while optimizing normal tissue and OAR sparing. In future study, rodent model will be used for preclinical study, comparing the treatment outcome of SFRT with conventional RT. Additionally, the integration of SFRT with immune therapy/chemotherapy shows promise for enhancing therapeutic outcomes, warranting further preclinical and clinical explorations.