AbstractID: 4607 Title: Quantitative Characterization of Tumor Vascular Dysfunction in High-Grade Gliomas Prior to and During Radiotherapy

Introduction: Vascular properties within and adjacent to tumors may not be distinguishable by cerebral blood flow [CBF] or cerebral blood volume [CBV] alone, since the rates of CBV change may not be proportional in magnitude to CBF change. Hence, the empirical and physiological relationships between CBF and CBV were examined to estimate vasculature-specific hemodynamic characteristics in high-grade gliomas.

Methods: Twenty patients with gliomas were studied with dynamic contrast-enhanced T2* MRI [DCE-MRI] before and during radiotherapy [RT]. CBF and CBV were calculated from DCE-MRI and the relationships between the two were evaluated using two different metrics: The physiological measure of Mean Transit Time [MTT]=CBV/CBF; and, Empirical fitting of CBV and CBF using the power law, expressed as CBV=Constant*$(CBF)^{\beta}$. Three tissue types were assessed, Gd-enhanced tumor volume [GdTV], non-enhancing abnormal tissue located beyond GdTV but within the abnormal hyperintense volume on FLAIR images [NEV], and normal tissue in hemisphere contralateral to tumor [CNT]. Effects of tissue types, CBV magnitudes (low[L], medium[M] and high[H] CBV), before and during RT, on MTT and β were analyzed by factorial ANOVA.

Results: Both, MTT and β were significantly different ($p<0.009$) among the three tissue types. MTT increased from CNT(=1.60s) to NEV(=1.93s) to GdTV(=2.28s) ($p<0.0005$). The power exponent β was significantly greater in GdTV(=1.079) and NEV(=1.070) than CNT(=1.025), but β in NEV and GdTV were not significantly different from each other. β increased with increasing CBV magnitude. There was a significant decrease in MTT and a significant increase in β in tumor (GdTV) and peritumoral (NEV) tissue during RT compared with pre-RT values.

Conclusions: β was strongly dependent on CBV magnitude and MTT on tissue type. Progressive abnormalities in functional characteristics of the vascular bed were noted, with significant disorder in tumor, but mild abnormality in peritumoral tissue. Early vascular response to radiation was first observed in functional rather than structural properties.