ALTERED STRUCTURAL CONNECTIVITY IN WIDELY DISTRIBUTED BILATERAL HEMISPHERIC NETWORKS OF PATIENTS WITH GlioBlASTOMA

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BACKGROUND: Glioblastomas (GBMs) typically involve the cerebral white matter and infiltrate well beyond the enhancing bulky tumor seen on MRI; thus, they can disrupt white matter fiber tracts. In this study, we evaluated how unilateral GBMs affect the structural organization of hemispheric networks.

METHODS: Ten patients with newly-diagnosed unilateral GBM (age: 61 ± 11 years, 6 males, 4 left-sided, tumor size: 34.1 ± 22.7 cm³) and 10 healthy controls (age: 67 ± 8 years, 5 males) underwent 3T diffusion-weighted MRI. Whole brain tractography was performed using a recently developed approach (independent component analysis with ball-and-stick model; Jeong et al., Magn Reson Med, 2013;70:441-53). In each subject, a total of 116 cortical regions of interest were generated by fitting a deformable template resulting in a 116x116 connectivity matrix where the elements quantify the pair-wise connectivity scores (i.e., fiber numbers connecting any two cortical regions which were normalized to the corresponding tract lengths). From this matrix we calculated three network properties in both hemispheres: global efficiency (characterizing structural integration), local efficiency (characterizing structural segregation), and clustering coefficient (characterizing structural complexity).

RESULTS: GBM patients showed significantly reduced global efficiency, local efficiency, and clustering coefficients in both affected and contralateral hemispheres, as compared to the control group (p < 0.0001 in all comparisons). Larger tumor size was associated with more severely reduced global efficiency (p = 0.007 and p = 0.004 in affected and contralateral hemisphere, respectively), local efficiency (p = 0.02 and p = 0.003) and clustering coefficient (p = 0.04 and p = 0.006). Signs of intrahemispheric network reorganization were also observed in the affected hemisphere of individual patients.

CONCLUSIONS: The structural organization is less efficient and less complex in both cerebral hemispheres of patients with unilateral GBM, although regional reorganization may occur on the affected side. Larger tumors are associated with more severe hemispheric network abnormalities. These alterations in widely-distributed neuronal networks may underlie some of the neurocognitive co-morbidities in these patients.