Glioma grading using standardized rCBV depends on tumor type

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Target Audience: Neuro-oncologists, neuroradiologists, neurosurgeons, brain tumor imaging scientists

Purpose: To show the utility of standardized rCBV in characterizing human gliomas by grade and type.

Introduction: Human gliomas are comprised of astrocytomas, oligodendrogliomas, and mixed oligoastrocytomas. Attempts to grade and differentiate gliomas using advanced imaging techniques have resulted in conflicting results, likely because patient data was grouped by tumor grade without regard for tumor type.[1,2] Histopathological evaluation of biopsy samples remains the gold standard for the diagnosis of brain tumors, even though MR imaging provides invaluable additional information on tumor behavior.[3] Here, we present the use of standardized rCBV to classify gliomas as a function of glioma tumor type and grade.

Methods: The histopathological findings of 157 tissue specimens from 34 adult patients who underwent brain tumor biopsy or resection were used for this study. Histopathological diagnosis for each tissue specimen was obtained from the neurosurgical pathology report and according to the WHO brain tumor grading system. Preoperative MR imaging was co-registered to the MRI uploaded for surgical navigation, and a 3 mm spherical region of interest (ROI) was drawn manually for each distinct tissue sampling site using AFNI software.[4] The ROIs were based on intraoperative screenshots from a StealthStation® S7™ surgical navigation unit (Medtronic, Minneapolis, MN). Standardized leakage-corrected RCBV (sRCBV) values were determined from raw DSC data processed with IB Neuro™ software (Imaging Biometrics LLC, Elm Grove, WI).[5] The sRCBV was used because of its reduced interpatient and interstudy variability.[6] Only positive non-zero sRCBV values were included in the analysis. The median ADC values were likewise determined using the same ROIs. Statistical sample independence for both sRCBV and ADC was confirmed before conducting statistical analyses.

Results: The study results are summarized in Figures 1 and 2 below.

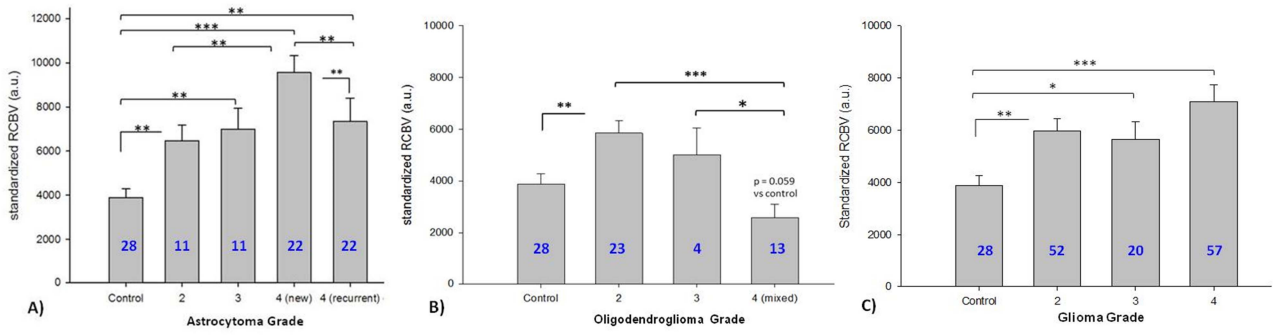

Figure 1. Comparison of median rCBV values extracted from ROIs defined by STEALTH sampling location. The sRCBV readily differentiates between A) astrocytoma and B) oligodendroglioma grades. C) The capability to differentiate between the grades is lost when astrocytomas, oligodendrogliomas, and mixed oligoastrocytomas are combined for analysis. Grade 4(mixed) = GBM with an oligodendroglial component. Blue numbers indicate sample counts. Rank-sum t-test: * p<0.05 ** p<0.01 *** p<0.001

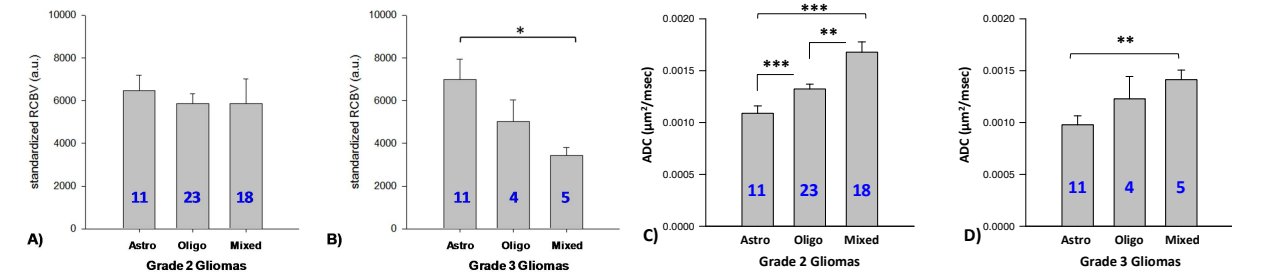

Figure 2. Comparison of sRCBV and ADC across glioma types for each grade. While the sRCBV values for grade 2 tumors were comparable across type (A) the ADC measures demonstrate a significant distinction (C). For grade 3 tumors both sRCBV and ADC show a distinction between tumor types (B,D). Blue numbers indicate sample counts. Rank-sum t-test: * p<0.05 ** p<0.01 *** p<0.001

Discussion: We presented compelling evidence that histologically different gliomas are also biologically distinct, characterized by significant differences in perfusion and diffusion measures. The contrasting sRCBV measures observed with advancing glioma grade are likely due to the inherent vascular characteristics of astrocytomas and oligodendrogliomas.[7,8] Moreover, our study confirms previous observations that gliomas should not be grouped by grade without regard for type to prevent dilution of the statistical power of the results.[1,2]

Conclusion: Standardized RCBV plays an important role in glioma characterization.

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