Region-of-Interest Analysis vs. Non-Region-of-Interest Histogram Analysis in the Evaluation of Cerebral Gliomas

R. J. Young[1], E. Pollack[1], H. Lu[1], J. Babb[1], G. Johnson[1], M. Law[1]
[1]Radiology, NYU Medical Center, New York, NY, United States

INTRODUCTION: Dynamic susceptibility contrast perfusion magnetic resonance imaging (DSC MRI) of gliomas is most commonly analyzed using region-of-interest (ROI) measurements. We compare the routine ROI method with ROI and non-ROI histogram methods in the grading of glial neoplasms.

METHODS: Ninety-two patients with primary glial neoplasms underwent conventional and DSC MRI. Routine ROI measurements of the maximal glioma abnormality were determined from cerebral blood flow (CBF_{max}), cerebral blood volume (CBV_{max}) and relative CBV ($rCBV_{max}$) color maps. The three histogram methods applied to CBF, CBV and rCBV maps were ROI-based 1) Tumoral (H_T) and 2) Peritumoral (H_P), and non-ROI based 3) Total Tumoral using all acquired perfusion slices without segmentation (H_{TT}). Perfusion metrics were compared to histopathologic grades using a three-tiered Ringertz system at volumetric resection or stereotactic biopsy. Statistical analysis was performed with independent unequal variances samples t-test and Spearman's correlation. Bonferroni-correction was applied due to the large number of correlations being examined and to exert familywise control over type I errors.

RESULTS: $rCBV_{max}$ was significantly correlated with tumor grade ($r=0.734$, $p<0.0001$), outperforming CBF_{max} and CBV_{max} metrics. H_T-, H_P- and H_{TT}-rCBV analysis was significant using multiple measures ($p<0.0005$). For the three histogram methods, the highest correlations occurred with H_T-rCBV-SD ($r=0.718$), H_P-rCBV-SD25 ($r=0.724$) and H_{TT}-rCBV-SD50 ($r=0.685$). To differentiate low (I/III) and high (II-III/III) grade tumors, $rCBV_{max}$ exhibited significant differences ($p<0.0001$), as did H_T-rCBV using median, mean, SD, mean50, SD50, mean25, SD25, mean10, SD10, and peak position ($p<0.0005$). Set at the same 95% sensitivity, the metrics achieved 80% specificity for $rCBV_{max}$ and up to 97% for H_T, H_P and H_{TT} rCBV.

CONCLUSION: Glioma rCBV histogram analysis is nearly as effective as $rCBV_{max}$ analysis in grading cerebral gliomas. Further refinement of the total tumoral histogram method may allow for automated, non-ROI based analysis of DSC MRI, potentially improving intra-observer, inter-observer and inter-institutional reproducibility. This will allow multi-center trials for novel anti-angiogenic agents.

Figure 1. (A) $rCBV_{max}$, (B) H_T, (C) H_P, and (D) H_{TT} maps with respective signal intensity and histogram curves are shown for a glioblastoma multiforme spanning the corpus callosum.