Histogram Analysis of Relative Cerebral Blood Volume Measurements in Cerebral Gliomas: An Interobserver and Intraobserver Reproducibility Study

R. J. Young[1], E. Pollack[1], G. Pivawer[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 (1-2). To compare inter- and intra-observer reproducibility for different techniques of measuring relative cerebral blood volume (rCBV) perfusion metrics in patients with cerebral gliomas, using both ROI and non-ROI techniques.

METHODS: Three independent observers performed rCBV measurements in 86 patients with cerebral gliomas while blinded to the final histopathologic grade. Each case consisted of the unprocessed or raw perfusion data and conventional MR images. Four different methods were compared. Method 1, $rCBV_{max}$, used the highest value obtained from four small fixed diameter ROIs targeted to the maximal abnormalities in the tumor. Fourteen metrics were collected for Methods 2-4 using histogram analysis. Method 2, tumoral $rCBV_T$, used a single ROI drawn around the maximal tumor diameter on any single axial slice. Method 3, peritumoral $rCBV_P$, was defined by a semi-automated dilatation process. Method 4, total tumoral $rCBV_{TT}$, measured rCBV using all acquired perfusion images (7-10 images covering the tumor) without segmentation of brain tissue. The first evaluation by all observers was performed over a two week period and the second evaluation was performed 4-8 weeks later. The levels of reproducibility were determined using the coefficient of variation (CV) for between readers (CV_{BR}) and within readers (CV_{WR}). Lower CVs indicate higher reproducibility.

RESULTS: A representative case with all four methods is shown in Figure 1. The lowest CVs are summarized in Table 1. Method 4 ($rCBV_{TT}$) was the most reproducible technique for both CV_{BR} and CV_{WR}, representing 8 of the top 10 and 7 of the top 10 metrics, respectively. Method 1 ($rCBV_{max}$) was ranked in the bottom quartile of lowest CV_{BR} (33/43) and CV_{WR} (35/43).

Figure 1. The four methods are: (A) $rCBV_{max}$ using small fixed diameter ROIs, (B) $rCBV_T$ tumoral ROI, (C) $rCBV_P$ peritumoral ROI, and (D) $rCBV_{TT}$ non-ROI technique.

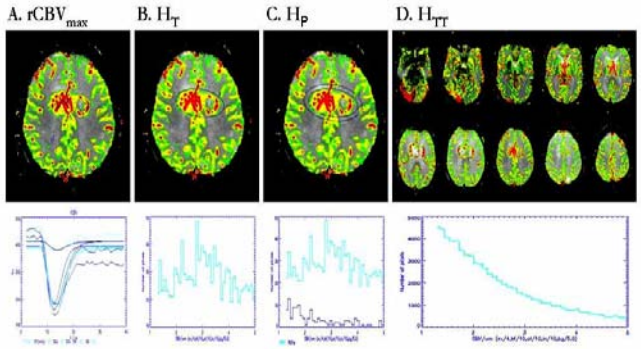

Table 1. Best metrics for each method.

	Method 1 ($rCBV_{max}$)	Method 2 ($rCBV_T$)	Method 3 ($rCBV_P$)	Method 4 ($rCBV_{TT}$)
CV_{BR}	40.9	SD=22.5	A1SD=16.7	Mean10=12.3
CV_{WR}	27.3	SD=13.4	A1SD=11.8	Mean10=9.0

* *SD* standard deviation, *A1SD* Area under 1 SD, *Mean10* mean of top 10% of values

CONCLUSION: Interobserver and intraobserver reproducibility of rCBV was good using all four techniques. Total tumoral histogram analysis, a non-ROI technique, achieved the best CV. Further refinement of non-ROI analysis of perfusion MR data may lead to standardized, automated techniques for analyzing perfusion MR data.

REFERENCES:

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