DIFFUSION-WEIGHTED MR IMAGING USING MONO-EXPONENTIAL, BI-EXPONENTIAL AND MONO-EXPONENTIAL HIGH-B VALUES MODELS IN THE GRADING OF GLIOMAS

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TARGET AUDIENCE: Scientists and clinicians who are interested in multi-model DWI and accurately grading gliomas.

PURPOSE: To evaluate and compare the potential of diffusion-weighted imaging (DWI) using mono-exponential, bi-exponential and mono-exponential high-b values models in the grading of gliomas.

METHODS: A total number of 39 patients with pathologically proved gliomas (21 high-grade, 18 low-grade) were enrolled in this study. All patients underwent a routine scan on a 3.0T MR scanner (GE Discovery MR750, Mikauwee). DWI was obtained using an echo-planar sequence with a TR of 4000 ms, a TE of 112 ms, an FOV of 24 × 24 cm^2, a matrix of 128 × 128, a slice thickness of 4 mm and no gap. Fifteen b values from 0 to 5000 sec/mm^2 were used in three diffusion directions. An isotropic apparent diffusion coefficient (ADC); a true diffusion coefficient (ADCslow) and a pseudo-diffusion coefficient (ADCfast) calculated from DWI using a bi-exponential model[1]; as well as an ADChigh calculated from DWI using mono-exponential high-b values (2500，3000, 4000 and 5000 sec/mm^2) model were compared between high- and low-grade gliomas. Binary logistic regression and receiver operating characteristic analysis were used for statistical evaluation.

RESULTS: ADC and ADCslow values were significantly lower in high- than in low-grade gliomas ($p < 0.05$), whereas ADCfast and ADChigh values were significantly higher in high- than in low-grade gliomas ($p < 0.05$). There're no significant differences among the areas under curves yielded by ADC (0.826), ADCslow (0.835), ADCfast (0.818) and ADChigh (0.829) ($p > 0.05$).

DISCUSSION: ADC has limitation in reflecting the diffusion features *in vivo* accurately[1]. ADCslow may remove the influence of perfusion and could reflect the true diffusion coefficient, whereas ADCfast is a perfusion-related parameter[1]. Aquaporin 4 (AQP4), a kind of water channel protein, is the main determinant of membrane permeability[2]. ADChigh may primarily reflect the membrane permeability, and the elevated ADChigh in high-grade gliomas is consistent with the higher expression of AQP4[3].

CONCLUSION: ADC, ADCslow, ADCfast and ADChigh derived from multi-model DWIs are useful in the grading of gliomas. ADChigh may be a novel parameter to reflect AQP4 expression in grading gliomas and guide personalized treatment.

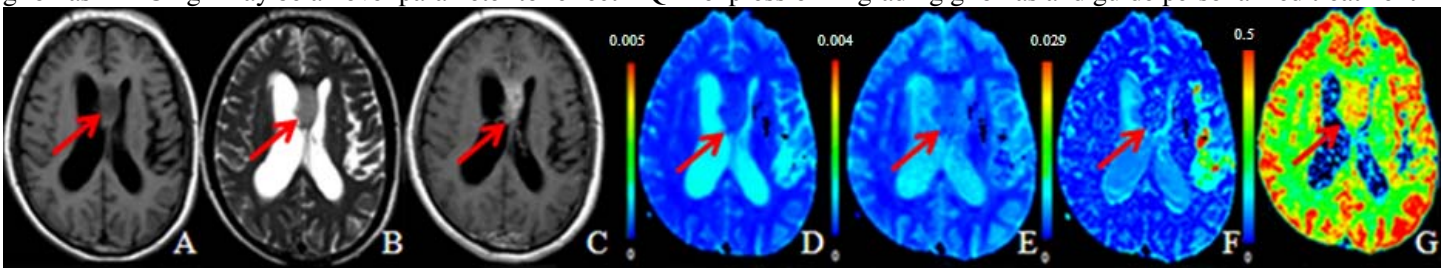

Figure 1. A 54-year-old male with glioblastoma (WHO grade IV) in the corpus callosum. The tumor shows hypointense signal (arrows) on T1WI (A), iso- to hyperintense signal on T2WI (B), and heterogeneous enhancement on post-gadolinium T1WI (C). The ADC map (D) and the ADCslow map (E) show decreased values, whereas the ADCfast map (F) and the ADChigh map (G) show elevated values in the tumor.

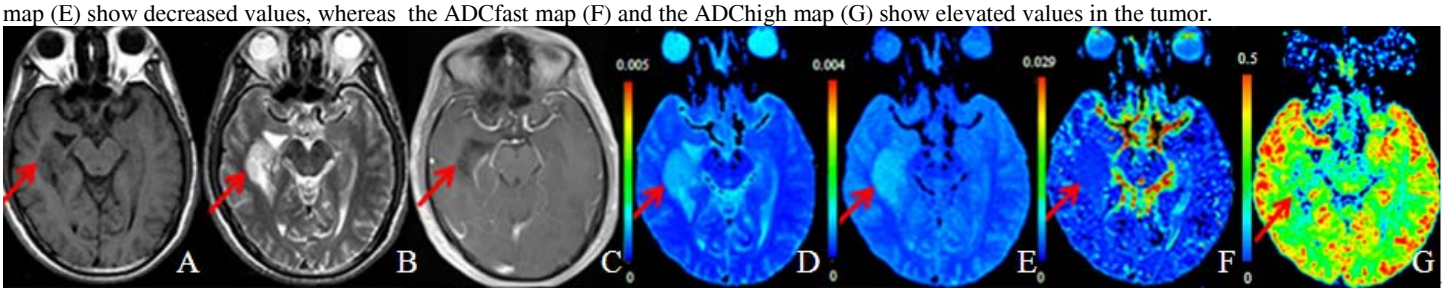

Figure 2. A 43-year-old female with astrocytoma (WHO grade II) in the right temporal lobe. The tumor shows hypointense signal (arrows) on T1WI (A), hyperintense signal on T2WI (B), and no enhancement on post-gadolinium T1WI (C). The ADC map (D) and the ADCslow map (E) show elevated values, whereas the ADCfast map (F) and the ADChigh map (G) show decreased values in the tumor.

REFERENCES: 1. Le Bihan D, et al. Separation of diffusion and perfusion in intravoxel incoherent motion MR imaging. Radiology. 1988;168(2):497-505. 2.Tourdias T, et al. Aquaporin 4 correlates with apparent diffusion coefficient and hydrocephalus severity in the rat brain: a combined MRI-histological study. Neuroimage. 2009; 47(2):659-666. 3. Ding T, et al. Role of aquaporin-4 in the regulation of migration and invasion of human glioma cells. Int J Oncol. 2011;38(6):1521-1531. Supported by grant from NSFC 81271565 and 31470047.