

The application of multiple b-value DWI with a stretched-exponential model in preoperative grading of cerebral gliomas

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Purpose:Standard DWI with a mono-exponential model has been applied in assessing glioma characterization, preoperative diagnosis and early assessment of the effectiveness of therapy. However, the signal intensity attenuation of brain water does not follow monoexponential decay and will deviate from straightness when b-factor exceed 1000 s/mm². A more accurate description of signal attenuation with high b-value over wide b-value range requires more complex biophysical models. The purpose of this study was to evaluate the application value of multiple b-value DWI in grading of astrocytomas with stretched- exponential model.

Materials and Methods: 59 patients with cerebral gliomas (2-grade group: N= 20; 3-grade group: N=15; 4-grade group: N=24. 42 men and 7 women, mean age 43.8 years) underwent standard DWI and multiple b-value DWI on GE 3.0T MR system. ADC maps were created using mono exponential model with b-value of 1000 s/mm², $S(b)/S(0)=\exp(-b \times ADC)$; DDC and α maps were created by applying the stretched- exponential model with multiple

b-values of 0, 1000, 2000, and 4000 s/mm². $S(b)/S_0 = \exp \left\{ - (b \times DDC)^\alpha \right\}$. Where α is the stretching parameter, which relates to intravoxel water diffusion heterogeneity, and is limited to values between 0 and 1. The DDC is the distributed diffusion coefficient, representing mean intravoxel diffusion rates. ADC, DCC of solid regions of tumors and α of tumors in different groups were measured and analyzed with One-way ANOVA, respectively.

Results: □Average DDC in the 2-, 3-,and 4-grade group was 1.36, 0.90, 0.73×10⁻³mm²/s,respectively. Moreover, DDC had significant difference between any two groups(P<0.05),and much more higher in 2-grade group than those in 3,and 4 -grade groups(Fig1-3). □α in the 2-, 3-,and 4 -grade group was 0.859, 0.814, 0.839, respectively. There was a significant difference in α between 2-grade and 3- or 4-grade group (P <0.05) and no significant difference between 3- and 4-grade group. □ADC in 2-, 3-,and 4-grade group was 1.47, 1.03, 0.91×10⁻³,respectively. There was a significant difference in ADC between 2-grade and 3- or 4-grade group (P<0.05) and no significant difference between 3 and 4 -grade group.□There was a strongly positive correlation between DDC and ADC in the solid part of tumors(R= 0.8493; P<0.001).

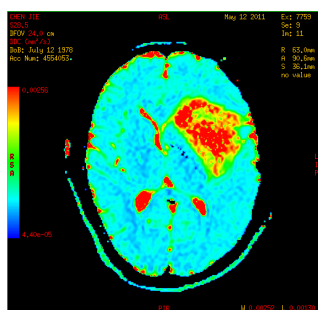


Fig1

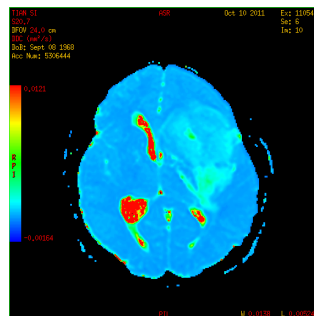


Fig2

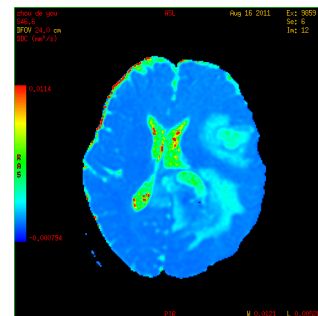


Fig3

DDC maps in 2-grade glioma, 3-grade glioma, and 4-grade glioma

Conclusion: The stretched exponential model multi-b DWI provides a more accurate estimate in the preoperative grading of gliomas than the standard mono-exponential model DWI. It can be a new imaging marker to differentiate the grade of gliomas and evaluate the effectiveness of therapy.

Reference:

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