Comparison of Monoexponential,Biexponential and Stretched-Exponential Models of DWI in Grading Gliomas

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Target audience: Neuroradiologists.

Purpose: DWI has been one of the hottest tools used in neurological diseases in recent years. Previous studies commonly used quantitative ADC obtained from monoexponential fit to grade gliomas. However, contradictory findings have been reported in different studies(1)(2). The biexponential and stretched-exponential models could offer additional informations. The purpose of our study was to compare the values of three different models of DWI in grading gliomas.

Methods:DWI using three different models with 15 b values range from 0 to 5000 sec/mm^2 at 3T MRI was performed on 17 high- and 12 low-grade gliomas proved by histopathology after MR examination. The monoexponential model was used to generate ADCstandard maps. The parameters of diffusion coefficient (ADCslow), pseudo-diffusion coefficient(ADCfast) and perfusion fraction (f) derived from IVIM with biexponential analysis(3). Water diffusion heterogeneity index α and distributed diffusion coefficient (DDC) were obtained from stretched-exponential model(4). All the parameters were measured in solid parts of gliomas and compared between high- and low-grade gliomas. ROC curves were generated for each parameter to assess the AUC.

Results: ADCstandard values had no significant differences(P=0.08) whereas ADCfast(P<0.001) and ADCslow values (P=0.007) had significant dirrefences between high- and low-grade gliomas. ADCslow values is significant lower than ADCstandard in both groups(P< 0.001). α values was significantly lower in high- than that in low-grade gliomas (P<0.001). The pearson correlation coefficient betwwen DDC and ADCstandard was 0.751 and 0.985 respectively in high- and low-grade gliomas. α had the highest AUC(0.995).

Discussion: ADCslow and ADCfast may respectively reflect the effects of diffusion and perfusion in gliomas. ADCslow may be more accurate than ADCstandard in evaluating tumour cellularity. DDC and ADCstandard measurements may be in better agreement in low- than in high-grade gliomas. α may be the best parameter for distinguishing high- from low- grade gliomas.

Conclusion: The biexponential and stretched-exponential models of DWI are useful tools in grading gliomas.

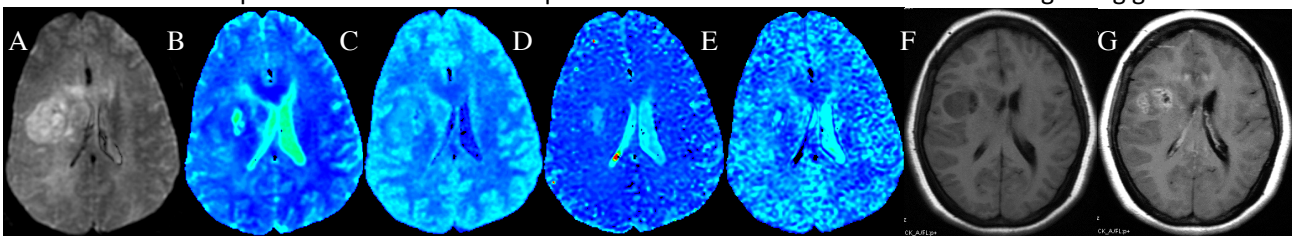

Fig 1. A 43-year-old woman with astrocytomas (WHO Ⅱ grade). A, b=1000; B, ADCstandard; C, ADCslow; D, ADCfast; E, α ;F, T1WI; G, T1C+ maps.

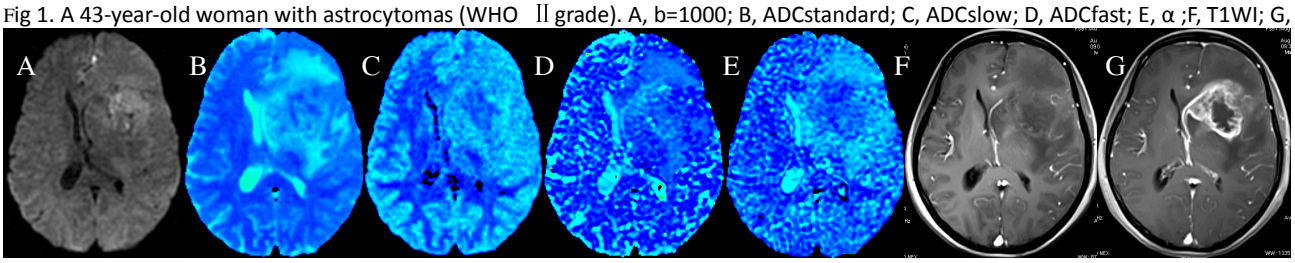

Fig 2. A 59-year-old man with glioblastoma (WHO Ⅳ grade). A, b=1000; B, ADCstandard; C, ADCslow; D, ADCfast; E, α ;F, T1WI; G, T1C+ maps.

References: (1)Zonari et al, Neuroradiology. 49:795–803, (2007). (2)Kang et al, Radiology. 261:882–90, (2011). (3)Le Bihan et al, Radiology. 168:497-505(1988). (4)Bennett et al, Magn Reson Med. 50:727–34 (2003).