Comparison of mono-exponential, bi-exponential and stretched-exponential models derived parameters in detecting renal cell carcinomas

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ObjectivesTo evaluate the diagnostic accuracy of mono-exponential, bi-exponential and stretched-exponential modelsdiffusion weighted imaging (DWI) in patients withrenal cell carcinoma(RCC).

Methods24 patients with RCC underwent DWIwith fifteen *b* factors (0, 10,30, 50, 70, 100,150,200, 300,400,600, 800,1000,1500,2000 sec/mm²) on a 3.0T MR scanner. The isotropic apparent diffusion coefficient (ADC); the true diffusion coefficient (ADCslow), pseudo-diffusion coefficient (ADCfast), and fraction of perfusion (f) ; the water diffusion heterogeneity index (α) and distributed diffusion coefficient (DDC) derived from the mono-exponential, bi-exponential and stretched-exponential models were calculatedin the solid area of tumors and in the corresponding regions of contralateral normal renal parenchyma.Univariatereceiver operating characteristic (ROC)analysis was implemented and areas under the curve (AUC) were compared among all parameters using MedCalc (MedCalcSofware, Mariakerke, Belgium) to determinethe largest Yoden index and corresponding sensitivities and specificities in the diagnosis of RCC.

ResultsThe mean ADC, ADCslow and α value was significantly lower in RCC than in normal renal parenchyma   ($P < 0.001$). ADCfast value was significantly higher in RCC than in normal renal parenchyma ($P < 0.001$). In the ROCanalysis, the AUC for α was 0.977 and significantly larger than other parameters with a sensitivity of 100% and a specificity of 75.0%. There was a strong correlation between ADC and ADCslow (r=0.908, P＜0.001).

Discussion and Conclusions DWI isa noninvasive MR technique that is sensitive to water molecular diffusion in biological tissue. However, ADC value calculated by a mono-exponential model alone may not be able to accurately reflect water molecular diffusion in vivobecause of the influenceof the microcirculation of blood in capillaries[1]. Some recent studies have suggested that bi-exponential and stretched-exponential DWI models might provide more accurate information about the water diffusion[2-3]by separating water molecular diffusion frommicrocirculation and describing the heterogeneity of intravoxel diffusion rates and the distributed diffusion effect. Comparing with parameters derived from mono-exponential and bi-exponential models, the α derived from stretched-exponential model may provide the most accurate information in the diagnosis of RCC.
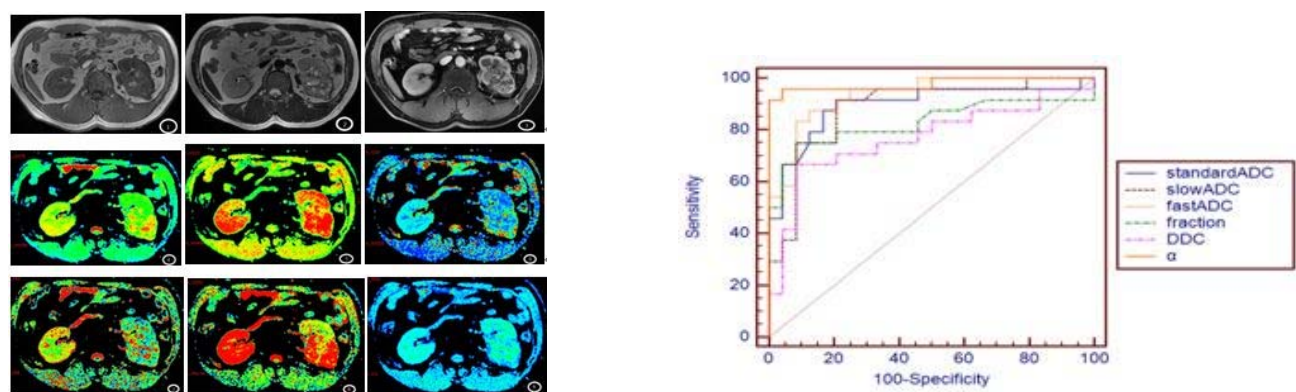
A 59-year-old man with Fuhrman grade III clear cell renal cell carcinoma in the left renal.(1)T1WI(2)T2WI(3)PostgadoliniumT1WI(4)ADC(5)ADCslow(6)ADCfast(7)f(8)DDC(9)α

Receiver operating characteristic (ROC) curvesshow performance of diffusion-weighted imaging

References[1]Le Bihan D, Radiology1988;168(2):497-505.[2]Le Bihan D, Radiology 1986;161(2):401-407.[3]Bennett KM,MagnReson Med 2003;50(4):727-734.