Diffusion Kurtosis Imaging of Transplanted Kidneys: Preliminary Results

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INTRODUCTION: Diffusion kurtosis imaging (DKI) is based on a non-Gaussian model, so it can better reflect the microstructural complexity of biological systems than the conventional diffusion tensor imaging (DTI), which presumes Gaussian distributed water molecule displacement probability. Lanzman et al(1) reported that DTI was a promising noninvasive technique for functional evaluation of renal allografts. Recently, G. Pentang et al(2) indicated the feasibility of DKI in the human kidneys. The aim of this study was to evaluate the feasibility of DKI at 3 T for functional assessment of transplanted kidneys.

METHODS: Between August 2014 and October 2014, 11 renal transplant recipients were prospectively recruited in this study and examined at a 3 T magnetic resonance (MR) scanner with a 32-channel torso phased-array coil. For DK imaging, single shot echo-planar in the axial orientation were obtained by using 3 b-values of 0, 1000 and 2000 mm^2/s and 15 diffusion directions. Region-of-interest (ROI) measurements were performed to determine fractional anisotropy (FA), mean kurtosis (MK), axial kurtosis (Ka) and radial kurtosis (Kr) of the cortex and the medulla of the kidneys. Relationships between DKI parameters and allograft function, determined by the estimated glomerular filtration rate (eGFR), were assessed by using Pearson correlation coefficient.

RESULTS: The DKI images and parameter maps in a 44-year-old woman with eGFR of 74.98 ml/min/1.73m^2 are shown in Fig 1. (A: DK image obtained with a b value of 0 s/mm^2, B: FA map, C: MK map, D: Ka map). Allografts showed the following mean values: FA 0.191±0.024 and 0.259±0.047, MK 0.515±0.033 and 0.527±0.013, Ka 0.521±0.042 and 0.499±0.025, Kr 0.494±0.029 and 0.513±0.021 in cortex and medulla respectively. FA was significantly greater in medulla than in cortex, while cortical Ka showed significant greater values than medullary Ka. Cortical MK (r= -0.832, p=0.002), Ka (r= -0.893, p<0.001), Kr (r= -0.750, p=0.008) and medullary Ka (r= -0.710, p=0.014) showed a negative and significant correlation with eGFR (Fig 2).

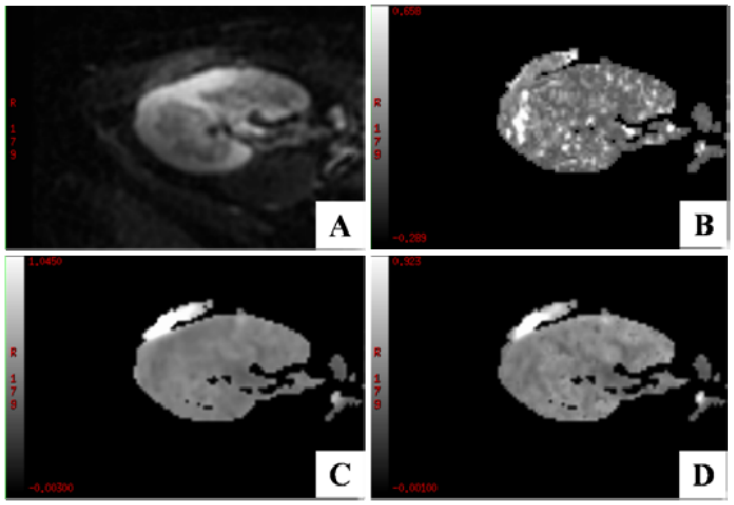

Fig 1. DKI images and parameter maps in a 44-year-old woman

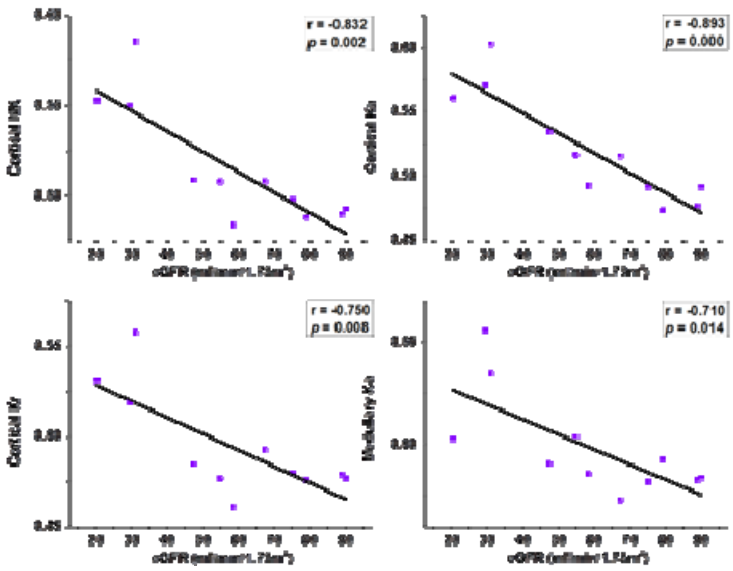

Fig 2. Correlation between DKI parameters and eGFR

DISCUSSION AND CONCLUSION: In our study, Ka correlated with eGFR in both cortex and medulla. As interstitial fibrosis are generated in kidneys with impaired function, water molecular diffusion within the biological tissues would be restricted, leading to the higher kurtosis parameters in DKI. In conclusion, it is possible that DK imaging may serve as an effective model for functional evaluation of transplanted kidneys.

References:

1. Lanzman RS, et al. Radiology. 2013;266(1):218-25.
2. Pentang G, et al. Magnetic resonance imaging. 2014;32(5):413-20.