

Longitudinal Follow-up of Kidneys from Living Donors to Their Recipients by DWI.

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Introduction: Despite increasing applications of diffusion weighted MRI (DWI) in studies of native kidneys, only very few DWI studies have been performed in human renal transplantation [1-3], though with promising results. We performed a prospective longitudinal DWI study in living kidney donors and their corresponding recipients before and after transplantation. The unique situation in living renal allograft donation allows monitoring DWI changes in the same kidney *before* transplantation in the *donor* and *after* transplantation in the *recipient*, which will be presented in this abstract. In addition, effects of uninephrectomy in the remaining single kidneys in donors were studied, which will be presented in an accompanying abstract [4]. Aims of the study were I) to determine short and long term stability of diffusion and contributing micro-perfusion parameters, and II) to determine if these parameters are correlated in the kidney before and after transplantation.

Methods: Study Population: 13 healthy kidney donors and the corresponding 13 allograft recipients were enrolled for the study. All donors and 12 of 13 recipients completed the study. MR examinations were performed in donors before donation (Pre), and in donors and recipients 7 days (D07), 3 months (M03), and 12 months (M12) after living donation. In parallel, serum creatinine levels were obtained and were used to calculate the glomerular filtration rate (eGFR) using the MDRD formula [5]. The graft recipients underwent a standardized initial triple immunosuppressive protocol. All recipients had good renal function after M12.

MR Imaging: Coronal single shot EP-DWI was performed on a 3T MR scanner (Trio, Siemens) with 10 diffusion gradient b-values (10-700 sec/mm²) using respiratory triggering (TR = 1 resp. cycle, TE=52msec, FOV = 30x30cm², 3 avgs, parallel imaging, min. acq. time: 4:30min).

Processing: DWI processing was performed I) without separating diffusion and perfusion contributions, yielding a "total" ADC_T, and II) separating diffusion and perfusion, yielding ADC_D (mostly determined by diffusion), ADC_P (mostly determined by perfusion), and the perfusion fraction, F_P. ROIs were selected in both, cortex and medulla at the upper and lower pole and at mid-level for a number of slices covering large parts of the kidney.

Results: Pre-transplantation diffusion values (ADCs and F_P) of living donors were significantly higher in cortex than in medulla, while cortico-medullary ADC_T and ADC_D differences were lower in transplanted kidneys; however, the differences were still significant (Table 1, Fig.1). Over a time course of 1 year, all determined parameters remained remarkably stable (Fig.1). No significant difference was determined between D07, M03 and M12 for any parameter (p>0.2 for all). There was a non-significant trend for F_P in recipients to increase towards values obtained in donors. The constancy of all diffusion parameters over one year corresponded to eGFR, which also remained stable over one year. ADC values in cortex and F_P values in cortex and medulla increased significantly with eGFR (Fig. 2). Interestingly, cortical ADC_T and ADC_D obtained in recipients after transplantation correlated significantly with those obtained the same kidney before transplantation in the donor (Fig.3).

		ADC _T	ADC _D	ADC _P	F _P
Native (mean of both kidneys)	Medulla	184 ± 7	176 ± 11	3660 ± 1320	8.8 ± 3.6
	Cortex	197 ± 9	188 ± 11	3000 ± 1420	10.7 ± 3.0
	t-test	p<0.0001	p<0.0001	p<0.03	p<0.02
Transplanted (mean of all scans)	Medulla	183 ± 7	178 ± 6	3280 ± 1620	7.1 ± 2.3
	Cortex	189 ± 9	183 ± 9	2570 ± 1180	8.7 ± 2.0
	t-test	p<0.03	p<0.05	p<0.01	p<0.007

Table: ADC [$\times 10^{-5}$ mm²/sec] and F_P [%] of native and transplanted kidneys. Note: Here mean values of both native kidneys are presented, while Fig.1 displays values of the donated kidney.

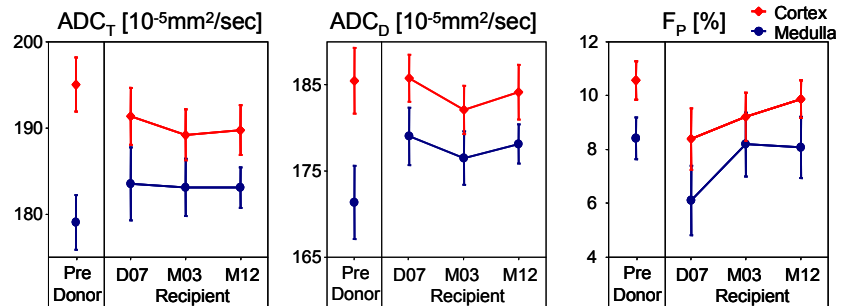


Fig1: Time courses of ADC_T, ADC_D, and F_P obtained in donors before (Pre), and in the same kidneys in recipients after explantation at D07, M03, M12. Error bars denote SEM.

Discussion: Corticomedullary differences of diffusion values in living donors pre-transplantation confirm previous studies in native kidneys [1]. Also the finding of lower corticomedullary ADC_T and ADC_D differences in transplanted kidneys corroborates previous findings [1], although in contrast in the current study the differences are still significant.

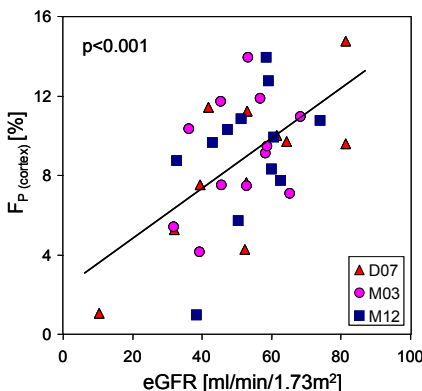


Fig.2: Comparison of F_P in the cortex of transplanted kidneys with eGFR.

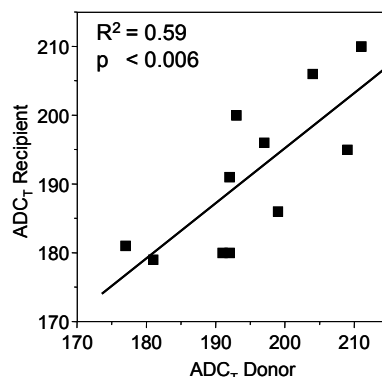


Fig.3: Comparison of ADC_T [$\times 10^{-5}$ mm²/sec] between donors and recipients in the same kidney before and on D07 after transplantation.

A main finding of this longitudinal study was that in allograft recipients with good renal function, all determined diffusion parameters remained constant over one year. This may prove valuable for future longitudinal studies to detect allograft dysfunction by relatively small diffusion changes.

The significant correlations between the same kidney in the donor and in the recipient before and after transplantation, indicates an important impact of the original kidney status on these parameters, outweighing other external parameters, like surgical factors, ischemic periods, or donor/recipient match.

References:

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