

## Follow-up of Living Kidney Donors After Transplantation by DWI reveals Compensatory Changes in the Remaining Kidney.

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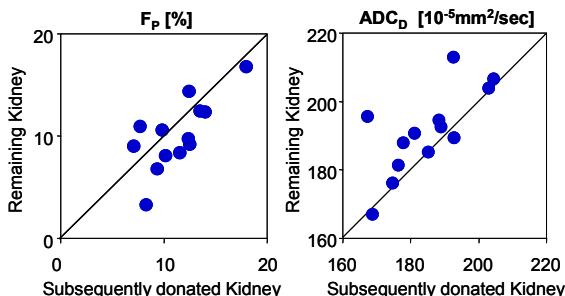
**Introduction:** A prospective longitudinal diffusion weighted imaging (DWI) study was performed in living kidney donors and their corresponding recipients before and after transplantation. This unique situation allows monitoring DWI changes in the same kidney *before* transplantation in the *donor* and *after* transplantation in the *recipient*, and, in addition, to examine effects of uni-nephrectomy in the remaining single kidneys in donors. In this abstract we present the DWI results obtained in renal donors a) of both kidneys before, and b) of the remaining kidney after explantation. The results of the kidneys in recipients will be presented in an accompanying abstract [1]. The remaining kidney of the donor exhibits compensatory mechanisms to overcome renal mass reduction due to uni-nephrectomy. After donation, kidney donors have an increased long-term risk to develop higher blood pressure, proteinuria and an accelerated loss of renal function [2], and it is likely that functional changes play an important role [3]. We hypothesize that diffusion parameters may help elucidate changes after kidney donation.

**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. The donors and the donated kidney (right or left) were selected according to conventional criteria for living kidney donation [4]. The donors underwent MR examinations before (Pre), and 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]. All donors had good renal function after M12.

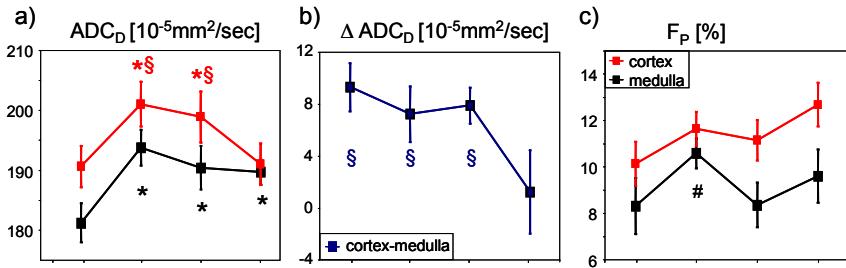
MR Imaging: Coronal single shot EP-DWI was performed on a 3T MR scanner (Trio, Siemens) with 10 diffusion gradient b-values (10-700 sec/mm<sup>2</sup>) using respiratory triggering (TR = 1 resp. cycle, TE=52msec, FOV = 30×30cm<sup>2</sup>, parallel imaging, min. acq. time: 4:30min).

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-explantation all determined parameters ( $ADC_D$ ,  $ADC_P$ ,  $ADC_T$ ,  $F_P$ ) in medulla and  $ADC_P$  and  $F_P$  in cortex were significantly correlated between the subsequently donated and remaining kidney ( $p<0.03$ , Fig.1).  $ADC_D$  and  $ADC_T$  in cortex and medulla were significantly higher in the remaining kidney ( $p<0.04$ , Fig.1). Most importantly,  $ADC_D$  (and similarly, but not shown  $ADC_T$ ) rose significantly in the remaining kidney at D07 after explantation of the contralateral kidney and remained high at M03. At M12,  $ADC_D$  declined again in cortex, while it remained significantly elevated in medulla, demonstrating only a trend towards lower values (Fig.2a). The corticomedullary difference of  $ADC_D$  ( $\Delta ADC_D$ ), which is present pre-transplantation, persisted until M03 and then vanished at M12 (Fig. 2b).  $F_P$  did not show a uniform trend, but a tendency towards increased levels at D07 (Fig.2c). The initial strong increase and subsequent slow decay of ADC values were paralleled by changes in eGFR (not shown in detail). The ADC values in medulla and the corticomedullary difference  $\Delta ADC_T$  and  $\Delta ADC_D$  correlated significantly with eGFR (see Fig. 3 for an example).

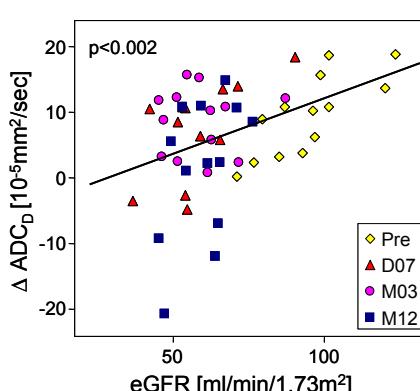


**Fig.1:** Comparison between the subsequently donated and the remaining kidney in donors for cortical  $F_P$  and  $ADC_D$



**Fig.2:** Example time courses of a)  $ADC_D$ , b) the corticomedullary difference in  $ADC_D$ , and c)  $F_P$  values from Pre via D07 and M03 to M12 after explantation. Significant changes are indicated: \* comparing versus Pre, # versus M03, § versus M12. Error bars indicate SEM.

**Discussion:** The results comparing both kidneys before donation confirm previous measurements demonstrating the feasibility and sensitivity of DWI measurements including estimation of  $F_P$  in kidneys. The significant differences between the subsequently donated and the remaining kidney may be due to the pre-selection criteria. Post-explantation compensatory mechanisms, induced by glomerular hyperfiltration [6], seem to be reflected by increased ADC values from pre-transplantation to D07 and M03. The corticomedullary diffusion differences, which are generally present in native kidneys, appear to diminish after explantation. This may correspond to the previously detected [7], and again here in the accompanying abstract described [1] small corticomedullary difference in transplanted kidneys. Although all donors had good renal function after M12 and the eGFR values span only a small range, significant correlations with diffusion parameters were detected. Further studies are required to determine if DWI measurements provide additional information beyond eGFR.



**Fig.3:** Comparison of the corticomedullary  $ADC_D$  difference with eGFR in donors

### References:

1. Vermathen P, et al. submitted to ISMRM, 2011.
2. Gossmann J, et al. Am. J. Transplant. 2005;5:2417.
3. Gross ML, et al. J. Am. Soc. Nephrol. 2005;16 Suppl 1:S27-S29.
4. Delmonico F. Transplantation 2005;79:S53-S66.
5. Levey AS, et al. Ann. Intern. Med. 1999;130:461.
6. Ohno A, et al. Kidney Int. 1995;48:712.
7. Thoeny HC, et al. Radiology 2006;241:812

### Acknowledgment:

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