Renal Size estimation by MRI in Living Renal Allograft Donation: Follow-up of the Remaining and of the Donated Kidney

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Introduction: After unilateral nephrectomy, the remaining kidney experiences compensatory hypertrophy, representing an early compensatory adaptation mechanism to achieve an adequate renal function [1,2]. The hypertrophy is associated with an increase in glomerular volume and a comparable increase in glomerular capillary volume [1]. The degree of hypertrophy may be related to the development of glomerular sclerosis [3]. Glomerular enlargement represents in transplanted kidneys also an adaptation mechanism to an increased metabolic demand [2,4]. Furthermore it has been shown that renal cortical volume diminishes over time in patients with chronically injured kidneys [5]. However, to our knowledge a longitudinal estimation of human renal sizes after transplantation in donors and recipients using MRI has not been performed.

The aim of the current study was therefore to prospectively investigate the effect of unilateral nephrectomy on the size of the remaining kidney in living renal allograft donors and following up on the size of the explanted kidney in the recipient. A diffusion-weighted imaging (DWI) study was performed and presented previously [6,7] in the same groups of subjects. Potential renal volume changes after unilateral nephrectomy or after implantation may also be important for interpreting DWI findings. The results of the current renal volume study were therefore correlated to the DWI results.

Methods: The local ethics committee approved the study protocol: all participants provided written informed consent. Thirteen healthy kidney donors (9 women, 4 men, mean age 55±12 years) and the corresponding 13 allograft recipients (4 women, 9 men, mean age 50±10 years) were randomly enrolled for the study. All donors and 12 of 13 recipients completed the study. The donors were selected according to conventional criteria for living kidney donation.

MR examinations were performed in donors before donation (Pre), and in donors and recipients approximately 7 days (D07, donors: 7.7±0.9 days, recipients: 9.0±3.1 days), 3 months (M03, donors: 103±7 days, recipients: 99±12 days), and 12 months (M12, donors: 358±5 days, recipients: 356±14 days) after living donation. The graft recipients underwent a standardized initial triple immunosuppressive protocol. The glomerular filtration rate (eGFR) was determined from serum creatinine levels. All donors and all recipients had stable renal function after M12.

Morphological imaging was performed on a 3T scanner (Tim Trio, Siemens, Germany) and included a coronal T2-weighted HASTE (TR=2000ms, TE=89ms, FA=150º) and coronal T1-weighted FLASH (TR=84ms, TE=3.1ms, FA=70º). All imaging sequences were performed in multiple breath-holds in expiration.

A point counting software developed in-house [8] was used in order to estimate renal size changes. Both the T2 -weighted HASTE and coronal T1-weighted FLASH were used for an estimation of renal size.

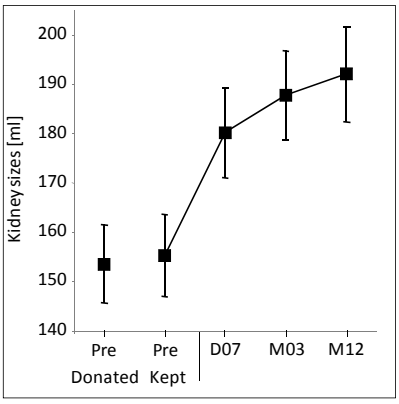

Fig. 1: Sizes of the donated kidneys and changes of the remaining kidneys in donors from before to 7 days, 3 months and 12 months post donation

Results: T1- and T2-weighted MRIs were both well suited to determine renal sizes, and yielded highly correlated results (R=0.94), although the sizes from the T2 images were lower by 8%. Sizes of the remaining and the subsequently explanted kidney in donors were strongly correlated (sizes from T2-weighted MRIs: 155±30 vs. 153±29ml, R=0.85, Fig.1).

Most importantly, the remaining kidney of donors increased significantly by approx. 15% very early after donation and continued to increase slightly but significantly until M12 to about 192±35ml (Fig.1). Renal sizes of allografts in recipients correlated significantly with those obtained in the same kidney before transplantation in the donor (R=0.63, p=0.03, Fig. 2). However, the allografts were increased by ~45% compared to the donated kidneys (225±35ml), which is probably primarily due to enlarged renal pelvis. After transplantation the allograft size remained constant.

eGFR increased significantly in donors and recipients with size (donors: R=0.52, p<0.001 and recipients: R=0.43, p<0.02).

In the previous published DWI study preformed on the same subjects and dates, a significant ADC increase was determined in the remaining kidney of donors, resembling the initial increase in renal size determined here. However, ADC values did not correlate significantly with renal size.

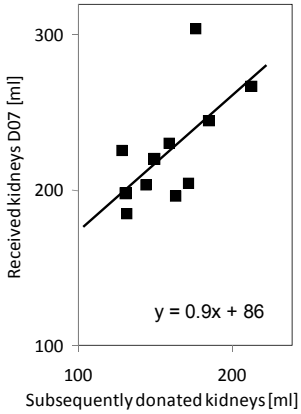

Fig. 2 : Size comparison of the same kidneys before and after transplantation in the donor and recipient, respectively.

Discussion & Conclusions: The remaining kidneys of donors exhibit compensatory size growth to overcome renal mass reduction due to unilateral nephrectomy. The allograft size remains constant after transplantation, although the total allograft size appears larger compared to the native kidneys. Potential growth changes should be considered as confounding factor, if functional changes in the kidneys are determined. Renal size estimations by MRI may prove as a sensitive parameter in follow-up studies.

References:

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