How does renal function change with nephrectomy? Initial experience using renal blood flow measured by arterial spin labelling MRI combined with 51Cr-EDTA filtration (GFR) to calculate renal filtration fraction

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Target Audience Individuals with renal interest: nephrologists, perfusion MRI physicists

Purpose To assess the effect of nephrectomy on renal function in healthy adult renal transplant donors. Renal Plasma Flow (RPF), using Arterial Spin Labelling (ASL), and Glomerular Filtration Rate (GFR) have been measured prior to and one year post-nephrectomy and combined to produce estimates of the Filtration Fraction (FF).

Methods Seven living kidney transplant donors (5 male, 2 female) underwent non-invasive MRI (without the use of exogenous contrast agents) as well as multiple blood samples ^{51}Cr-EDTA, prior to nephrectomy and one year after donation (Median = 421 days, Range = 365 – 610 days). MRI data included TrueFISP coronal-oblique data volumes acquired on a 1.5 T scanner. The volume of the donor's kidney was measured from MR anatomical images. ASL was performed using a multi-TI FAIR labelling scheme with a segmented 3D GRASE imaging module [1]. In order to enable blood flow quantification, T_1 and M_0 maps of the kidney were acquired using the same 3D GRASE sequence with the pre-saturation pulse enabled but the background suppression inversion pulses disabled. Using the ASL kinetic model [2], RPF (mL/min/100g) was calculated which was converted in to RPF for the whole kidney using the kidney volume at the time of each scan. Total scan time was less than 20 minutes.

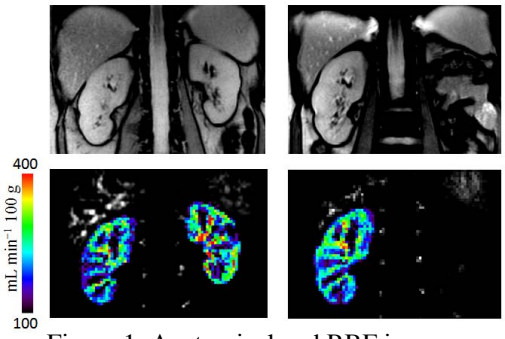

Figure 1: Anatomical and RBF images acquired pre and post nephrectomy.

^{51}Cr-EDTA with multi-blood sampling at 2, 3 and 4 hours post injection was undertaken and single exponential analysis was used to calculate the GFR and the results were expressed in mL/min.

The RPF and GFR obtained were used to calculate the FF. The % difference between the pre-nephrectomy and the results obtained a year post-nephrectomy of RPF, GFR, FF and renal volumes were also calculated.

Results RPF was successfully measured in all donors with a maximum of 34 % increase in 6 out of 7 donors and they all showed an increase in both GFR of 26 % - 72 % and FF of 8 % - 60 % after nephrectomy as shown in Table 1. The increase in RPF post-nephrectomy was not as great as the increase in GFR.

Donor Number	% Difference		
	RPF per kidney	GFR	FF
1	10.1	40.9	27.9
2	6.7	70.2	59.5
3	33.5	72.4	30.1
4	0.0	25.9	25.9
5	15.4	68.8	46.2
6	28.8	39.0	7.9
7	20.0	40.7	17.3

Table 1: Percentage difference in GFR, RPF and FF between pre and post-nephrectomy examinations

Discussion This study is the first to measure RPF non-invasively in kidney donors before and after donation. These results show that the increase in FF is mainly due to the increase in GFR (hyperfiltration) as RPF increased by a lesser extent. When the relationship between GFR and RPF is altered, i.e. hyperfiltration is not associated with a proportionate increase in RPF, renal failure due to glomerulosclerosis is a likely outcome. Only the measurement of FF has the potential of detecting this loss.

Conclusion ASL allows measurement of RPF non-invasively, which combined with GFR allows the calculation of FF. The FF might provide a sensitive biomarker to assess potential renal donors who are considered borderline for donation.

References 1. Cutajar M et al. *MAGMA* 2012; **25**: 145-153. 2. Buxton RB et al. *Magn Reson Med* 1998; **40**: 383-396.