

## DCE MR Renography Measurement of Renal Function in Patients Undergoing Partial Nephrectomy

S. K. Kang<sup>1</sup>, W. C. Huang<sup>2</sup>, J. L. Zhang<sup>1</sup>, M. Stifelman<sup>2</sup>, M. Bruno<sup>1</sup>, K. Arhakis<sup>1</sup>, E. F. Suan<sup>1</sup>, V. S. Lee<sup>1</sup>, and H. Chandarana<sup>1</sup>

<sup>1</sup>Radiology, NYU Langone Medical Center, New York, New York, United States, <sup>2</sup>Urology, NYU Langone Medical Center, New York, New York, United States

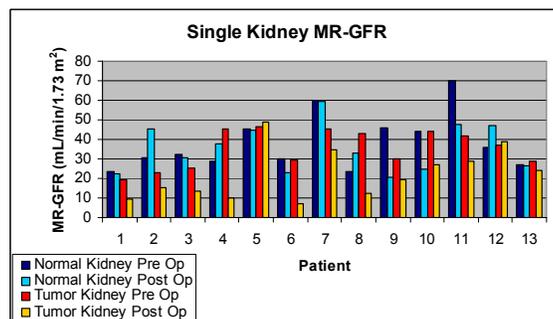
**Purpose:** Partial nephrectomy is now commonly performed to treat non-metastatic, localized surgically amenable renal neoplasms up to 7 cm in size. The importance of preserving renal function in these patients is increasingly emphasized in the urology literature; most afflicted patients present in the 6th and 7th decades, may have underlying renal disease despite normal serum creatinine, and thus are at risk of progressing to chronic renal insufficiency. Currently, the only clinically practical methods of monitoring renal function are serum creatinine and eGFR, which are of limited sensitivity and accuracy and cannot assess individual kidney function. Measurement of single kidney GFR (SK-GFR) with MR renography (MRR) could guide operative management in three major ways: 1) assessing contribution of the diseased kidney to overall GFR, 2) choosing between open and laparoscopic approaches as these techniques differ in type and duration of ischemic risk to the operated kidney (1,2), and 3) predicting whether patients with baseline renal insufficiency in the contralateral kidney will be able to compensate for functional loss in the operated kidney. The goal of this study was thus to determine the feasibility of using MRR in pre- and post-operative evaluation of single kidney function in patients undergoing partial nephrectomy.

**Methods:** In this HIPAA-compliant, IRB-approved prospective study, 13 subjects (6 males, 7 females; mean age 53 years) with renal neoplasms planned for surgical resection underwent pre-operative and immediate post-operative (within 72 hours of surgery) MRI, and 5 of these patients returned for follow-up MRI at 6 months. The partial nephrectomy approach was open (cold ischemia) in 3 patients and laparoscopic (warm ischemia) in 10 patients. Pre- and post-operative eGFR were calculated using the Modification of Diet in Renal Disease (MDRD) equation. In addition to the standard clinical MR imaging for renal mass evaluation at our institution, coronal dynamic contrast-enhanced (DCE) MRR was performed at 1.5 T (Avanto, Siemens) using TWIST, an undersampling technique (3), with a 5-second delay after administration of 4 cc gadolinium-DTPA contrast medium (TR/TE = 2.33/0.77, flip angle 12°, slice thickness 2.5 mm, bandwidth 650 Hz/voxel, voxel size 2.4 x 1.7 x 2.5 mm). Following 21 initial measures at 1.2 second temporal resolution in a long breath hold (29 seconds), sets of 3 measures were performed at 30 second intervals for 4 minutes. Semi-automated image registration and segmentation of the 3D MRR data sets were performed to produce aortic, renal cortical, and medullary signal intensity versus time curves. These signal curves were converted to concentration vs. time curves for the renal cortex, medulla and aorta, and application of a 3-compartment tracer kinetic model yielded MR-GFR for each kidney (4). The pre and post-operative eGFR and total MR-GFR values were compared. In 5 patients, pre and post-operative SK-GFR were compared with 6 month SK-GFR to assess interval change.

**Results:** Preoperative MR-GFR ranged from 43 to 112 mL/min/1.73 m<sup>2</sup> overall. MR-GFR of the operated kidney decreased in the immediate post-operative period by an average of 38 ± 27%. Decrease in the operated SK-GFR was seen in 11 patients, and this decrease in SK-GFR was greatest in patients with warm ischemia time greater than 40 minutes and lowest in patients with cold ischemia (Table 1). Non-operated contralateral kidneys demonstrated variable changes in GFR in the immediate-postoperative period (Fig1). 4 out of 5 (80%) patients with baseline pre-operative MR-GFR less than 60 mL/min/1.73 m<sup>2</sup> failed to demonstrate compensatory increase in SK-GFR. Of the 7 patients with baseline MR-GFR over 60 mL/min/1.73 m<sup>2</sup>, 3 patients showed compensatory increase in MR-GFR in the contralateral kidney. Of the 5 patients who had 6 month follow-up MRI, 3 of the 5 patients recovered function to near-baseline MR-GFR. No pattern of ischemic times or warm versus cold ischemia was observed in this small sample size. However, one patient with baseline MR-GFR less than 45 mL/min/1.73 m<sup>2</sup> failed to recover function. eGFR and MR-GFR showed moderate correlation overall (r=0.6) without statistically significant difference between eGFR and MR-GFR in either the pre-operative or post-operative state (p>0.1). Furthermore, we found the eGFR overestimated the MR-GFR by approximately 25%, which is consistent with previous reports (5). In particular, MR-GFR decreased by more than 30 mL/min/1.73 m<sup>2</sup> in 3 patients, and eGFR detected this change in only 1 patient.

Ischemia Type	Baseline MR-GFR (mL/min/1.73 m <sup>2</sup> )	Baseline Operated Kidney SK-GFR (mL/min/1.73 m <sup>2</sup> )	Decrease in Operated Kidney SK-GFR (%)
Cold Ischemia	76	33	26 ± 28
Warm Ischemia (all cases)	73	36	41 ± 27
Warm Ischemia (< 40 min)	69	32	34 ± 25
Warm Ischemia (≥ 40 min)	82	44	57 ± 30

**Table 1.** Warm ischemia was associated with greater decrease in operated kidney SK-GFR.



**Fig. 1.** SK-GFR decreased in 11/13 operated kidneys. Non-operated kidney GFR increased in 4 patients, decreased in 4 patients, and remained stable in 5 patients.

**Conclusion:** DCE MR renography can be used pre- and post-operatively to evaluate single kidney function in patients undergoing partial nephrectomy as an adjunct to routine anatomic imaging, requiring less than 5 minutes added acquisition time and very low doses of gadolinium contrast. Our study demonstrates that this tool may be used to quantitatively monitor the impact of different surgical approaches on the ipsilateral kidney function and to assess the ability of contralateral kidney to compensate for this decrease in function of the operated kidney.

### References:

- Huang WC, Levey AS, Serio AM et al. *Lancet Oncol.* 2006; 7: 735-740
- Yossepowitch O, Eggener SE, Serio A, et al. *J Urol.* 2006; 176: 1339-1343
- Song T, Laine AF, Chen Q, et al. *Magn Reson Med.* 2009; 61:1242-1248
- Lee VS, Rusinek H, Bokacheva L, et al. *Am J Physiol Renal Physiol.* 2007; 292: F1548-F1559
- Vivier PH, Storey P, Zhang JL et al. *Proceedings of ISMRM annual meeting 2010:* 325