3.0 Tesla Magnetic Resonance Angiography (MRA) for Comprehensive Renal Evaluation of Living Kidney Donors: Pilot Study with Computerized Tomography Angiography (CTA) Comparison

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INTRODUCTION AND OBJECTIVE: The number of living donor renal transplants performed in the United States has greatly increased in recent years, with over 6500 performed in 2005 alone (1). The majority of living donor kidneys are harvested laparoscopically, and preoperative imaging of renal vasculature is an important adjunct exam. Specifically, the number of renal arteries and veins, as well as the presence of early arterial bifurcation or late venous confluence, are crucial in determining suitability for laparoscopic nephrectomy. Computed tomography angiography (CTA) is the current gold standard for preoperative imaging of renal donors, and offers superb correlation with surgical anatomy (2). Magnetic resonance angiography (MRA) offers multiple advantages over CTA. These include the lack of ionizing radiation with MR and a lower incidence of adverse reactions to the gadolinium used for MRA when compared with the iodinated contrast used for CTA (3). We evaluated the utility of 3.0 T MRA in comprehensive assessement of the renal anatomy of potential kidney donors.

MATERIALS AND METHODS: After IRB approval was obtained, ten consecutive renal donors underwent 16-MDCT angiography (CTA). For the CTA, images were acquired in the arterial and nephrographic phases with 60% overlap and 0.6-mm reconstruction after 120 mL of iohexol was injected at 4 mL/sec. Utilizing a Siemens Trio 3.0T MRI scanner, all patients then underwent multiplanar imaging of the abdomen and pelvis before and after administration of intravenous gadolinium. Images were retrospectively evaluated in a random fashion blinded to patient data, with CTA and MRA evaluations done in consensus. All images were evaluated with respect to number and branching pattern of all renal arteries and veins, as well as opacification of collecting system, renal pelvis, ureters, and bladder. MRA results were compared with CTA findings.

RESULTS: CTA was the gold standard against which MRA was compared in evaluation of ten patients (20 kidneys). In these 20 kidneys, 30 renal arteries were detected on CTA. MRA detected 27 of these 30, missing 3 small accessory renal arteries (<4 mm). CTA detected a total of 23 renal veins, all of which were detected on MRA. Sensitivity and specificity of MRA for detecting early arterial bifurcation (<2 cm from lateral aspect of aorta on the left side, within the retrocaval segment on the right side) were 75% and 100%, while accuracy was 93%. Sensitivity and specificity of MRA for detecting late venous confluence (<1.5cm from the lateral aspect of the aorta on the left, <1.5cm from the anastomosis with the IVC on the right) were 100% and 88%, while accuracy was 91%. MRA missed 2 early arterial bifurcations which CTA detected, and called 2 late venous confluences which CTA did not. MRA detected all minor renal vein variants seen on CTA, including 4 lumbar veins and a duplicated IVC. MRA also detected all renal parenchymal anomalies seen on CTA (renal scars), as well as a duplicated collecting system seen on CTA. MRA missed 2 small (1 mm) calcifications seen on CTA. Opacification of all parts of the urinary tracts by both modalities were also graded, and results are shown in table 1.

CONCLUSIONS: 3.0T MRA enabled excellent detection of arterial and venous renal anatomy. Vessels missed by MRA were small and unlikely to be of clinical significance. MRA detected all renal parenchymal abnormalities, but missed small calcifications seen on CTA. MRA was notably worse for opacification of the kidneys and upper/middle ureters than was CTA. Although the sample size was small, this is the first direct comparison of 3.0T MRA with CTA in comprehensive evaluation of renal anatomy. 3.0T MRA has excellent potential as a substitute exam for evaluating the urinary tract in patients unable to tolerate CTA for various reasons, including impaired renal function.

Table 1:	CTA	MRA
Collecting system	4.4	3.6
Renal pelvis	4.6	3.8
Ureters (upper 1/3)	4.2	3.3
Ureters (mid 1/3)	3.9	3.2
Ureters (lower 1/3)	2.7	2.7
Bladder	4.5	4.5

Table 1: All figures are mean opacification of given lumen of urinary tract, graded from 1 (poor) to 5 (excellent), on review of both CTA and MRA exams.

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