

Characterization of Renal Masses with Arterial Spin Labeling MRI in Patients with Impaired Renal Function in the Era of Nephrogenic Systemic Fibrosis

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Introduction: The most reliable sign to characterize a renal mass as a neoplasm on contrast-enhanced imaging studies is the detection of enhancement, which confirms vascularity and tumor perfusion. In clinical practice renal mass perfusion is typically evaluated with contrast-enhanced computed tomography (CT) or Magnetic Resonance (MR) imaging. However, the nephrotoxic effect of iodinated contrast media limits its use in patients with moderate to severe renal failure. Furthermore, gadolinium-based contrast agents, once considered safe in the setting of impaired renal function, have been recently associated with nephrogenic systemic fibrosis (NSF), a potentially life-threatening systemic disease in these patients. This has led to implementation of new policies worldwide that restrict the use of gadolinium contrast agents, thus creating a need for alternative methods for evaluation of renal masses in patients with moderate-to-severe renal insufficiency. With MR imaging, arterial spin labeling (ASL) can be used to measure blood flow into tissue by magnetically 'labeling' the nuclear spins of the endogenous water in arterial blood. Qualitative and quantitative images of blood flow can be generated without I.V. contrast material. ASL has shown promise in characterizing tumor perfusion in several research trials (1). Our aim was to retrospectively evaluate the capacity of ASL MRI in the assessment of tumor perfusion of renal masses in patients with impaired renal function in clinical practice.

Material and Methods: Between May 1st and October 31st, 2007 sixty-six consecutive patients were referred for MR evaluation of one or more suspected renal masses. Following standard procedures at our institution, renal function was screened in all patients prior to MR and patients with an estimated glomerular filtration rate (eGFR) <30 mL/min/1.73 m² underwent 1.5T MRI without receiving I.V. contrast. Seven patients had an eGFR below this threshold and underwent MRI using the non-contrast portion of our routine clinical "renal mass protocol" which includes 2D T1-weighted in-phase/opposed phased gradient echo, T2-weighted single shot fast spin echo (SSFSE), and 3D fat-saturated T1-weighted spoiled gradient echo (LAVA) sequences. For evaluation of blood flow in renal masses, ASL was performed using a single slice through the center of the mass in the axial, coronal, and/or sagittal plane depending on the location of the mass. Multiple separate acquisitions were obtained in patients with more than one suspicious mass. All MR examinations were monitored by a radiologist to ensure adequate anatomic prescription of the ASL slices. Perfusion imaging was achieved with a pseudo-continuous labeling (2), optimized background suppression, and a SSFSE acquisition. The labeling was performed in an axial plane 8-10 cm superior to the center of the kidneys for 1500 ms followed by a 1500 ms post-labeling delay. The SSFSE sequence used a field of view of 40 cm, a 128x128 matrix and a slice thickness of 8-10 mm. A repetition time of 6 s was used to allow for recovery of blood signal and the subjects were instructed to breath in the quiet period between acquisitions. Sixteen averages of label and control were acquired for a total acquisition time of 3.5 minutes. ASL images were prospectively evaluated by the radiologist covering the body MR service the day of the examination. Initial interpretations of the MR examinations were retrospectively evaluated and correlated to available pathological, clinical, or imaging follow-up.

Results: Ten suspicious renal masses were evaluated in 7 patients (6 males, 1 female) with a mean age of 71 years (range 57-77). All 7 patients had moderate-severe renal failure with a mean and median eGFR of 24 mL/min/1.73 m² (range 7-30) and 28 mL/min/1.73 m², respectively. Five patients had a single kidney due to prior nephrectomy for cancer, one had a single functional kidney due to chronic contralateral hydronephrosis, and one had a renal transplant secondary to polycystic kidney disease. Four masses demonstrated perfusion on ASL MRI. One patient with prior nephrectomy for renal cancer and a contralateral stable enhancing mass on prior gadolinium-enhanced MR examinations showed size stability and perfusion on ASL MRI. Two patients had highly perfused infiltrating renal masses. None of them were surgical candidates and follow-up imaging confirmed progression of disease with tumor in the inferior vena cava in one and liver metastasis (confirmed at biopsy) in the other (Fig. 1). MR was consistent with a small cystic renal cell carcinoma with perfusion on ASL MRI in one patient although pathologic confirmation of this recent MR examination is not available. Six masses showed no perfusion on ASL MRI and none of these have shown progression on limited follow-up. In one patient ASL MRI showed no perfusion of a hemorrhagic cyst obstructing his kidney and subsequent follow-up confirmed shrinkage of the lesion (Fig. 2).

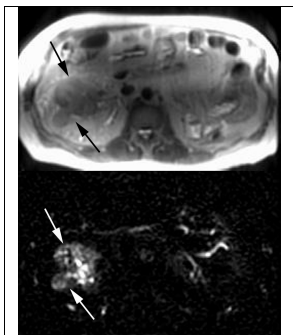


Fig. 1. Reference image (top) and ASL perfusion image (bottom) in a 66 year-old male with prior left nephrectomy for renal cell carcinoma and new mass in the right collecting system resected via open pyelotomy 3 months prior now with acute renal failure. An infiltrating mass (arrows) is demonstrated with high perfusion on the ASL MR image. Follow-up MR confirmed disease progression.

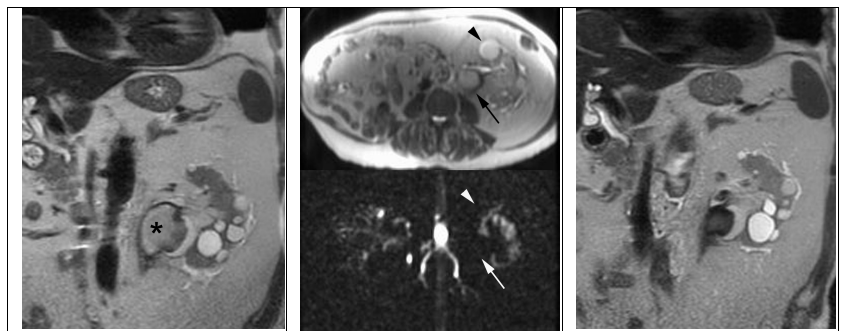


Fig. 2. Coronal T2-W SSFSE image (left) in a 77-year-old male with remote history of complete remission after IL-2 therapy for metastatic right renal cell carcinoma presenting with obstruction of his left kidney due to a hemorrhagic mass (asterisk). The patient was scheduled for a left nephrectomy. Axial ASL MRI (center) showed no perfusion of the mass (arrow) and an adjacent simple cyst (arrowhead). Follow-up T2-W SSFSE (right) confirms decrease in size of the cyst.

Discussion: ASL MRI provides an alternative to contrast-enhanced cross-sectional studies (i.e. CT, MR) for characterization of renal masses in patients with moderate-to-severe renal insufficiency. High perfusion on ASL MR imaging seemed to correlate with aggressive biologic behavior of the tumors in 2 of our patients. Lack of perfusion in a large hemorrhagic renal cyst was reassuring and allowed us to recommend avoiding a scheduled nephrectomy of the single kidney in one patient. Follow-up imaging in that patient confirmed a decrease in size of the hemorrhagic cystic lesion. The lower levels of sensitivity for detection of tumor perfusion with ASL MRI remain unknown and deserve further investigation.

Conclusion: Our initial experience suggests that ASL MRI may be a valuable alternative to contrast-enhanced cross-sectional imaging studies for characterizing renal masses by identifying renal mass perfusion in patients with impaired renal function. The sensitivity of ASL for low levels of tumor perfusion requires further investigation in larger longitudinal studies.

References:

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