MRI of Kidneys
Practical Approach to Non-invasive Diagnosis

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76 yo M, h/o RCC, restaging

Spatial resolution vs Contrast resolution
58 yo F, RCC & hepatic metastases
Renal lesions

**Solid:**
- Renal cell carcinoma
  - Clear cell
  - Papillary
  - Chromophobe
- Angiomyolipoma
  - Lipid rich & lipid poor
- Oncocytoma
- Transitional cell
- Lymphoma

**Cystic:**
- Non-neoplastic renal tubular cysts
  - Bosniak classification
- Cystic renal cell carcinoma
- Multilocular cystic nephroma
Renal cell carcinoma- clear cell

- **Pathology:** tumor derived from proximal convoluted tubules; clear cytoplasm from internal glycogen and/or lipid

- **MRI features**
  - *Dynamic contrast:* heterogeneous, arterial enhancement
  - *T2:* heterogeneous, increased signal; variable cystic changes
  - *In and opposed phase:* variable non-uniform loss of signal on opposed phase images (lipid)
  - **Other:** renal vein thrombosis, metastases
58 yo F, clear cell RCC
58 yo F, clear cell RCC
86 yo F, clear cell RCC

Precontrast  Arterial  Delayed

T2 FS  Opposed phase

DWI  In phase
62 yo M, clear cell RCC
62 yo M, renal vein invasion
41 yo M, clear cell RCC, venous invasion
62 yo M, clear cell RCC; staging
Renal cell carcinoma - papillary

- **Pathology:** papillary tumor with macrophages and intracellular hemosiderin

- **MRI features**
  - **Dynamic contrast:** delayed enhancement
  - **T2:** mostly hypointense (some variability)
  - **In and opposed phase:** variable non-uniform loss of signal on in-phase images (iron)
  - **Other:** indolent, rarely metastasize, common and can be multiple in cystic disease of uremia
68 yo M, multifocal papillary RCC
66 yo M, papillary RCC

Precontrast  Arterial  Delayed

DWI  T2
65 yo F, renal cyst on CT

Initial study

3 yrs later
65 yo F, papillary RCC
60 yo M, papillary RCC, atypical T2

Precontrast  Arterial  Delayed

T2 FS  Opposed phase  In phase

DWI
32 yo M, mixed papillary-clear cell
Angiomyolipoma

- **Pathology:** thick-walled vessels, smooth muscle and adipose tissue

- **MRI features**
  - **Dynamic contrast:** uniform, arterial enhancement, no accumulation in late phase
  - **T2:** hypointense
  - **In and opposed phase:** loss of signal on opposed phase imaging with mixed lipid/non-lipid AML
  - **Other:** loss of signal on T2FS if mostly lipid, DWI may show low restrictivity
52 yo M, angiomyolipoma
57 yo F, tuberous sclerosis
51 yo F, lipid poor AML
Angiomyolipoma - lipid poor

Precontrast  Arterial  Delayed
Ax T2

DWI
Out of phase
RCC - clear cell

RCC - papillary

AML (lipid poor)
Renal cell carcinoma - chromophobe

- **Pathology:** large, polygonal cells with granular, sometimes eosinophilic cytoplasm

- **MRI features**
  - *Dynamic contrast:* mild/subtle arterial enhancement (less than clear cell RCC)
  - *T2:* intermediate
  - *In and opposed phase:* no lipid
58 yo M, chromophobe RCC
41 yo M, chromophobe RCC
**Oncocytoma**

- **Pathology:** polygonal cells with granular, very eosinophilic cytoplasm

- **MRI features**
  - **Dynamic contrast:** arterial enhancement, variable intensity
  - **T2:** elevated, heterogeneous
  - **In and opposed phase:** typically no lipid
  - **Other:** central scar
39 yo F, oncocytoma

Precontrast  
Arterial  
Delayed  

T2 FS  
Opposed phase  
In phase
67 yo M, oncocyctoma
45 yo F, oncocytoma
28 yo M, chromophobe RCC
Oncocytoma vs RCC

- Chromophobe RCC
  - Pathology: large, polygonal cells with granular, sometimes eosinophilic cytoplasm

- Oncocytoma
  - Pathology: polygonal cells with granular, very eosinophilic cytoplasm
**Oncocytoma vs chromophobe RCC**

- Difficulty in accurately differentiating oncocytoma from chromophobe RCC on biopsy
  - Hybrid tumors exist
  - Oncocytoma-like areas may be present in chromophobe RCC
  - No immunohistochemical features proven to be reliable/specific


Chromophobe RCC

Oncocytoma
Transitional cell carcinoma

- **Pathology:** typically papillary urothelial carcinoma

- **MRI features**
  - *Dynamic contrast:* heterogeneous, delayed enhancement
  - *T2:* heterogeneous, hypointense
  - *Other:* infiltrative growth, collecting system obstruction and infundibular stenosis vs. external compression (e.g. RCC)
80 yo M, TCC
69 yo F, TCC

Precontrast  Arterial  Delayed

Ax T2  DWI  Cor T2
Lymphoma

- **Pathology:** most often secondary involvement; diffuse large cell lymphoma most common

- **MRI features**
  - **Dynamic contrast:** homogenous, delayed enhancement
  - **T2:** homogeneous, similar to spleen
  - **Other:** multiple, bilateral; associated nodal disease
58 yo F, lymphoma

Arterial

Delayed

Ax T2
68 yo M, large B-cell lymphoma
Renal cystic disease

- Bosniak classification (based on CT findings)
  - **Type 1**: simple cyst (imperceptible wall)
    - No follow-up, ~0% risk of malignancy
  - **Type 2**: few, thin (< 1mm) septa; hemorrhagic cyst < 3 cm
    - No follow-up, ~0% risk of malignancy
  - **Type 2F**: increased number of septa, minimally thickened; hemorrhagic cyst > 3 cm
    - Follow up ~6 months; ~10.9% risk of malignancy
  - **Type 3**: thick, nodular septa (indeterminate lesion)
    - Surgical assessment; ~54% risk of malignancy
  - **Type 4**: clearly malignant; frank RCC
    - Surgical assessment; ~100% risk of malignancy

Radiology. 2012 Jan;262(1):152-60
Radiology. 2014 Sep;272(3):757-66
CT or MRI for renal cysts?

- MRI has marked advantages in soft tissue resolution compared to CT
  - Upgrades or downgrades cyst classification due to improved ability to visualize the internal contents of the cyst
  - Relatively fewer indeterminate (type 2F and type 3) cysts

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Gallstones
Renal cell carcinoma - Cystic
35 yo M, renal cyst
RCC - cystic
52 yo F, renal cyst

Ax T2 FS

Ax MRCP

Cor T2

Cor post

Precontrast

Delayed
Multilocular cystic nephroma
Summary

➢ MRI and CT both demonstrate excellent sensitivity for the detection of solid and cystic renal lesions

➢ MRI holds advantages related to specificity of diagnosis
   ➢ More easily differentiate benign from malignant disease, especially for cystic lesions

➢ Accurate pre and postsurgical staging optimizes therapeutic decisions