MRI of Cystic and Solid Renal Masses: A review of the most important concepts

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Imaging Protocol Fundamentals

- Single shot T2
- 2D GRE In/Out-of-phase
- Pre and Post Multi-phase Gad 3D GRE FS
  - Optional
    - TFISP
    - “MRCP” Slab
    - Subtraction ($\text{Post Gd}$ minus $\text{Pre Gd}$ = Evaluation of Vascularized Tissue in Cyst)
Imaging Protocol Fundamentals

- **Single shot T2**
  - Water sensitive (Bright signal)
  - Cysts and cyst content
  - Collecting system
    - Hydronephrosis / Hydroureter
  - Fluid collections
    - Urinoma / Abscess
  - Flow void (Dark signal)
    - Blood vessels
**Imaging Protocol Fundamentals**

- **Single shot T2**
  - Fat suppression
    - Fat from water
    - Edema - inflammation
Imaging Protocol Fundamentals

- **T1 GRE In/Out of phase**
  - Intermediate levels of intracellular lipid
    - AML
    - Adenoma (Adrenal)
Imaging Protocol Fundamentals

- \textit{T1 3D GRE Pre/Post Gd}
  - Vessels
  - Tumors
  - Collecting system
Set Protocols

- 15 min scanning time
- 20 min room time
Renal Cystic Mass: Diagnostic options

MRI > US + CT
Normal Cortico-Medullary Differentiation (CMD)
Abnormal CMD

MRI 19:789-793, 2001
Two weeks post drug-related ARF
MRI Evaluation of Structure and Function

- **CMD** reflection of renal function assessed on routine fast imaging
CMD

CML Amyloid Kidneys
Iron Liver and Spleen
Evaluation of Renal Masses

- **Cystic** → *Usually benign*
- **Solid** → *Usually malignant*
Masses

- RCC - can be cystic or solid
  - Tubular endothelium
  - 3/10,000 or 36,000 incidence
  - 1/3 present with metastases
  - 12,000 deaths/yr
Cysts Classification
Cysts Classification

- **Congenital**
  - Multicystic Dysplastic Kidney

- **Genetic**
  - ARPKD
  - ADPKD

- **Cortical**
  - Simple cyst / Hemorrhagic-Proteinaceous
  - Multilocular Cystic Nephroma
  - Syndromes (Tuberous Sclerosis; Turner’s)
  - Hemodialysis – Cystic disease of uremia

- **Medullary**
  - Calyceal diverticulum
  - Medullary Sponge Kidney/Medullary Cystic Disease
  - Papillary Necrosis

- **Infectious**
- **Neoplastic**
Cysts Classification

- Most common clinically encountered cystic pathology
  - Benign cortical
    - Simple cyst
    - Mildly complex cyst
      - Hemorrhagic-Proteinaceous fluid
  - Most important diagnostic differentiation
    - Neoplastic
      - Moderate to highly complex cyst
        - Vascularized soft tissue components
Cysts Classification (aka Bosniak)

- Type 1: Simple
- Type 2: Mildly complex
- Type 3: Moderately complex
- Type 4: Highly complex

- **Intervention**
  - None
  - Possible to definite resection
Cysts Practical Classification

- **Benign**
  - No Treatment

- **Malignant**
  - Surgery/Ablation

- **Not certain**
  - Follow/Treat

?Role for biopsy - questionable in most cases
Cysts

Simple - Mildly complicated cyst
Blood-protein containing complicated cyst
Blood product/protein

T1  ↑ - ↑↑
T2  ↔ - ↓
High T1 Complex Cysts

- Subtraction
RCC with high fluid content
→ Cystic RCC
RCC – non-cystic
Low T2 and well vascularized + Interstitial uptake
RCC – cavitary ≠ cystic
Only vascularized around periphery
Mostly interstitial phase uptake
= Type IV
Cysts Classification

- Infection
Abscess / Infected Cyst
Renal abscesses

- ~1/1000 hospitalized patients

Intra-Renal:
- Rx: Abx +/- IR or surgery

Perinephric Abscesses:
- Rx: IR or surgery +ABX
Cysts Classification

- Congenital and Inherited Disease
Case Presentation 1
**APCKD**

- RCC uncommon
- Mostly simple and mildly complicated cysts due to protein/blood products
Cysts Classification

- Transplanted kidney – abnormal contained fluid structures
  - Urinoma
  - Seroma
  - Lymphocele
  - Renal cyst
  - Bladder diverticulum
- Other – possible mimickers
- Complications → compression/obstruction
Angiomyolipoma (AML)

- Vessels
- Smooth Muscle
- Lipid
Angiomyolipoma (AML)

- Vessels ("Angio")
- Smooth Muscle ("myo")
- Lipid ("lipoma")
Lipid-Suppression Imaging

1) In/Out-of-phase
   - Low to Intermediate lipid content
2) Fat suppressed (Freq./IR)
   - High lipid content
   - Adipocytes only
AML w High Lipid Fraction
AML w Intermediate Lipid

4.4 ms

2.2 ms
Adrenal Adenoma
Adrenal Adenoma
-Low lipid content
Adrenal Carcinoma
75F Multiple Renal Lesions

AML
Oncocytoma
Oncocytoma

- Benign histology but question of malignant growth potential
- Incidence not well established
  - Estimate up ~5% of all renal tumors
  - May be multifocal and/or bilateral ~10%
- Arises from the collecting tubule
- 1/3 – ½ have central scar
- Path DDx: Chromophobe RCC
Renal Neoplasms

- Sensitivity 100% for pre-metastatic disease
- Specificity 83% on surgical-path review
  - 17% of resected tumors are benign
Oncocytoma
Oncocytoma
RCC
TCC
TCC
Central RCC
Central RCC
**Urothelial Tumors**

- **TCC** – Transitional Cell Carcinoma
  - Urothelial origin
  - >70-80% of bladder tumors
  - ~2-4% upper tracts
  - ~2-10% bilateral
TCC
Bladder TCC
Endometrioma
MLCN
Multilocular Cystic Nephroma

- Rare renal mass (uncertain incidence)
- Benign
- < 4y mostly males
- > 30y mostly females
- Separated cysts
- Displaced renal pelvis
Multilocular Cystic Nephroma

- Recommend, at minimum, follow up looking for growth to differentiate from cystic RCC
  - 6,6,12,12,12 months surveillance
Cystic RCC (Type IV)
Future Directions

- Tumor Molecular imaging
  - Tumor fingerprinting
- Screening
Non-Invasive Evaluation of Renal Cystic/Solid Masses

Summary:

- MRI provides improved specificity through a variety of contrast mechanisms
- Combines information that may be derived from CT + US but without anatomic blind-spots (US) and improved soft tissue contrast without radiation or CIN (CT)