RENAL MASS IMAGING: CURRENT TECHNIQUES & ADVANCEMENTS

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Introduction

- Brief Overview of CT Protocols to optimize detection and characterization of primary and metastatic disease
- Cases
  - Renal Cell Carcinoma
  - Miscellaneous GU Tumors
- Subtyping RCC based on imaging?
OPTIMIZING CT PROTOCOLS
CT Protocols

- Standard CAP (Portal venous phase)
  - Prostate CA
  - Lung CA
- Dual Liver Protocol
  - Breast CA
  - Neuroendocrine tumors
  - Carcinoid
- Urology Specific Protocols
Imaging Modalities

Genitourinary Protocol

- **Indications:**
  - Hematuria
  - Suspected renal mass
  - Evaluation of ureters

- **Noncontrast Phase Imaging**
  - Precontrast attenuation of masses
  - Calcifications

- **Nephrographic Phase Imaging**
  - Maximum lesion conspicuity

- **Delayed Phase Imaging**
  - Filling defects in collecting systems, ureters, urinary bladder
Imaging Modalities

- **RCC Protocol**
  - **Indications:**
    - Follow up for patients with known RCC
  - **Noncontrast Phase Imaging**
    - Precontrast attenuation of masses
    - Calcifications
  - **Dual Liver Imaging**
    - Arterial phase due to hypervascular nature of RCC and its metastases
    - Portal venous phase for overall lesion detection
Imaging Modalities

- **TCC Protocol**
  - **Indications:**
    - Follow up for patients with known TCC
  - **Noncontrast Phase Imaging**
    - Precontrast attenuation of masses
    - Calcifications
  - **Split Bolus**
    - Portal venous phase for overall lesion detection
    - Delayed phase for filling defects
  - **Decreased radiation dose overall**
RENAL CELL CARCINOMA
Background – RCC

- #1 most common solid neoplasm of kidney
  - 3% adult malignancies
  - 90-95% malignancies of kidney

- USA
  - ~40K cases in 2007 (67% male)
  - ~9K deaths in 2007

- Worldwide
  - >100K deaths in 2001
Background – RCC

- Increased diagnosis in patients without clinical symptoms
- “Classic Triad” occurs in 10%
  - Flank Pain (40%)
  - Hematuria (40%)
  - Flank Mass (25%)
- 30% present with metastatic disease
Background – RCC

- Risk Factors
  - Cigarette Smoking
    - Factor in 33% cases
  - Obesity
  - HTN
  - Phenacetin
  - Acquired cystic disease of HD
Two probable mechanisms for arising
- De novo from solid adenomatous rests
- From epithelial lining of a cyst

Also, clustered cases with hereditary syndromes
Background – RCC

- Associated with hereditary conditions
  - Von Hippel Lindau
    - Autosomal dominant
    - Multiple cysts with papillary tufts
    - Risk of early, bilateral, and multiple RCCs
    - Requires yearly screening
Background – RCC

- Assoc w/ hereditary conditions (cntd)
  - Tuberous Sclerosis
    - Slightly increased risk of RCC
    - 2-4% of TS patients
  - Sickle Cell Trait
  - Renal Medullary Carcinoma
    - Aggressive, malignant variant
    - Poor prognosis
    - Young Patients
Diagnosis of RCC has changed

Previously, dx on ultrasound, excretory urograms, etc.

Mainstay of diagnosis today is CT
- Allows for lesion characterization
- Evaluation of distant mets
- Evaluation of vascular patency
Diagnosis – US

Ultrasound Findings
- Solid mass
  - Can help with DDx of solid vs cystic masses
- Vascularity
- Venous Invasion
- Adjacent LNs
CT Findings

- Enhancement
  - Precontrast phases are critical
  - 10-15 HU = “pseudoenhancement”
  - >15 HU = enhancement
- Fat
  - Angiomyolipoma?
Diagnosis – MR

**MRI**
- Good for patients with contrast allergy
- Good for vascular evaluation, specifically IVC and RV involvement
- Similar to CT
Solid Mass – DDx

- Renal Cell CA
- Oncocytoma
- Angiomyolipoma
- Transitional Cell CA
- Hematoma in setting of trauma
- Metastases
- Lymphoma
Which is malignant?

Similar age patients, both masses enhance
Which is malignant?

Oncocytoma

Renal Cell CA
Most Solid Masses – DDx (in reality)

- Renal Cell CA
- Renal Cell CA
- Renal Cell CA
- Renal Cell CA
- Renal Cell CA
- Renal Cell CA
- Everything else...
RENAL CELL CA – STAGING
Staging Systems

- Robson
  - Simple
  - Clinically Relevant and Useful
- TNM
  - AJCC Endorsed
  - More complex
Stage I (5-year survival: 96%)\(^6\)
Tumor $\leq 7$ cm in greatest dimension and limited to kidney.\(^4\,5\)

Stage II (5-year survival: 82%)\(^6\)
Tumor $>7$ cm in greatest dimension and limited to kidney.\(^4\,5\)

Stage III (5-year survival: 64%)\(^6\)
Tumor in major veins, adrenal gland, or perinephric tissue (not beyond Gerota's fascia) and/or 1 regional lymph node involved.\(^4\,5\)

Stage IV (5-year survival: 23%)\(^6\)
Tumor beyond Gerota’s fascia, $>1$ regional lymph node involved, and/or $\geq 1$ distant metastasis.\(^4\,5\)
Disadvantage of Robson system

- IIIA – invasion of RV, IVC
- IIIB – Regional LN involvement
- IIIC – Both

IIIA has markedly better survival rates than IIIB, and not significantly different from II
Renal Cell Carcinoma

- Distant organ metastases
  - Lungs 55%
  - Liver 25%
  - Bones 20%
  - Adrenal 20%
  - Contralateral kidney 10%
  - Other organs <5%
CASE 1

RCC with IVC invasion
RCC
CASE 2
CASE 2
RCC with necrotic lymphadenopathy
CASE 3
Hx of RCC
s/p L nephrectomy
CASE 3
Local and distant disease recurrence
CASE 4
Multiple RCC
IVC invasion
CT guided percutaneous bx
s/p partial nephrectomy
CASE 5
Solid enhancing RCC
s/p partial nephrectomy
RCC
CASE 6
CASE 6
Large RCC with mass effect on but no invasion of IVC
RCC
CASE 7
CASE 7
L RCC s/p R nephrectomy with hypervascular nodal and pancreatic mets
CASE 8
38 yo male with hematuria
6 weeks of abx, no improvement...now what?
Additional clinical history: sickle cell...diagnosis?
CASE 8
Renal Medullary CA
Hx of sickle cell
(TCC mimic in kidney)
CASE 9

Left TCC on MRI
SUBTYPING RCC USING IMAGING
Subtyping RCC

- **Clear Cell RCC**
  - “Clear” cells with abundant intracytoplasmic lipid/glycogen with intervening small blood vessels
  - Large size, necrosis and intravascular extension into the renal vein and IVC are common

- **Papillary RCC**
  - Papillary architecture consisting of cuboidal cells with granular cytoplasm covering a fibrovascular core
  - Foamy macrophages and intracellular hemosiderin common
  - Type 1 (basophilic) > Type 2 (eosinophilic) (better prognosis)
  - On NECT, pRCC can appear mildly hyperdense
  - Smaller tumors are relatively homogeneous and are typically hypovascular

*Courtesy of Brian Allen, M.D.*
Clear Cell Carcinoma (ccRCC)

Clear cells filled with lipid & glycogen

Courtesy of Brian Allen, M.D.
Imaging Features of ccRCC

- Viable components enhance avidly +/- necrosis
- Microscopic lipid is detected in up to 40% and has PPV for ccRCC of ≥ 95%

Courtesy of Brian Allen, M.D.
Imaging Features of ccRCC

Courtesy of Brian Allen, M.D.
Imaging Features of ccRCC

T2
T1 iso
CM
Neph

Courtesy of Brian Allen, M.D.
Imaging Features of ccRCC

Note: Not all ccRCC have evidence of intracellular lipid on MRI

Courtesy of Brian Allen, M.D.
Papillary Carcinoma (pRCC)

Papillary architecture with dark staining hemosiderin

Unenhanced (50HU)  65 HU  85 HU

Courtesy of Brian Allen, M.D.
MR Imaging Features of pRCC

- On MR, pRCC is typically iso on T1w, T2w and enhances less than renal parenchyma

Courtesy of Brian Allen, M.D.
MR Imaging Features of pRCC

- Pitfall: Other tumors, such as AML, TCC, and lymphoma can also appear hypointense on T2w
MR Imaging Features of pRCC

- Hemosiderin may be seen as areas of signal loss (susceptibility) on longer TE in-phase images

![Opposed Phase](image1)
![In Phase](image2)

Courtesy of Brian Allen, M.D.
CT = mainstay of RCC imaging
- Diagnosis
- Follow-up

“All that glitters is not gold...but most of it is”

Renal solid mass DDx starts and ends with RCC but other entities do occur

Subtyping of RCC is possible on imaging, especially MRI