Renal Anatomy

Patient #1: MM

- **HPI**: 50 yo M p/w:
  - 7 d of flank/back pain
  - 2 d of atypical chest pain
  - MM r/o for MI, r/o aortic dissection

- **HD #3**: MM developed acute L-sided flank pain

- **Initial Flank Pain Radiologic Workup**: supine and upright plain films of abdomen
Paucity of bowel gas on left; suggestion of soft-tissue mass
Menu of Imaging Tests for Renal Masses

- **Excretory Urography / Intravenous Pyelogram (IVP)**
  - Limited sensitivity for small renal masses
    - 67% for RCC 3 cm or less

- **US**
  - Reliable identification of simple renal cysts
    - (most renal masses)
  - Inexpensive

- **CT**
  - Current gold standard for evaluation of renal masses

- **MR**
  - For patients with contrast allergy
  - Elevated serum creatinine level
  - Hyperdense renal cyst


Patient MM: Further Radiologic Workup

Next, Patient MM had a non-contrast CT evaluation of his abdomen

– Non-contrast (non-ideal) because of patient’s compromised renal function
Patient MM: Non-contrast CT Abdomen #1 (Axial Images)

- **Well-circumscribed, low-attenuation lesion** = liver cyst
- **Well-circumscribed, high-attenuation lesion in kidney**
- **Low-attenuation lesions in kidneys**
Patient MM: Non-contrast CT Abdomen #2 (Axial Image and Sagittal Reconstruction)

cyst in kidney, calcification

perinephric hematoma w/ adjacent stranding
Patient MM: Non-contrast CT Abdomen #3 (Coronal Reconstructions)

- Liver cysts
- Perinephric hematoma w/ adjacent stranding
Patient MM: Renal US #1 (Transverse R)

PACS, BIDMC
Patient MM: Renal US #2 (Sagittal R)

Enlarged right kidney

17.18cm cysts
Patient MM

PMH:
- Adult polycystic kidney disease
- Chronic renal failure
- HTN
- Hyperlipidemia
- Atrial fibrillation

Diagnosis:
- Complication of PCKD w/ acute left kidney subcapsular hemorrhage into perinephric space
Bosniak Classification: Cystic Renal Masses

- **Category I**: simple benign cysts
- **Category II**: minimally complicated cysts
- **Category IIF**: minimally complicated cysts that require radiologic follow-up
  - Follow-up in 3 months, then 6 months, then 1 year
- **Category III**: moderately complicated cysts
  - Exhibit some radiologic features seen in malignancy
  - Need surgical exploration
- **Category IV**: clearly malignant cystic carcinomas

Features of Bosniak Category I

- Bosniak Category I = simple benign cysts
- **US**
  - Sharply marginated, smooth walls
  - Anechoic
  - Good through transmission
- **CT**
  - Sharp margination and demarcation from surrounding renal parenchyma
  - Smooth, thin wall
  - Water density content, homogeneous throughout (0-20 HU)
  - No enhancement following IV contrast

Review of Patient MM: Renal US #1

Cyst demonstrates:
- Sharply marginated, thin walls
- Anechoic
- Good through transmission

Category I
Complications of Simple Cysts

Simple Cysts complicated by:
- Hemorrhage
- Infection
- Inflammation
- Ischemia

Host response:
- Inflammatory cells
- Granulation tissue
- Neovascularity

Complicated Cysts:
- Calcification
- Hemorrhage
- Septations
- Wall Thickening
- Nodularity at Gross Inspection
### CT Criteria for Bosniak Classification

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Cat I</th>
<th>Cat II</th>
<th>Cat IIF</th>
<th>Cat III</th>
<th>Cat IV</th>
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<tbody>
<tr>
<td>Wall</td>
<td>Thin</td>
<td>Thin</td>
<td></td>
<td>More than thin</td>
<td>Thick or nodular</td>
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<tr>
<td>Septations</td>
<td>None</td>
<td>Few, thin</td>
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<td>More than few, thin</td>
<td>Numerous, thick</td>
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<tr>
<td>Calcifications</td>
<td>None</td>
<td>Few, thin</td>
<td></td>
<td>More than few, thin</td>
<td>Coarse</td>
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<td>Density pre-contrast</td>
<td>0-20 HU</td>
<td>0-20 HU</td>
<td>0-20 HU (except hyperdense cyst)</td>
<td>0-20 HU</td>
<td>&gt; 20 HU</td>
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<tr>
<td>Enhancement</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</tbody>
</table>


Review of Patient MM: CT #2

- **Cyst characteristics:**
  - Thin wall
  - Few, thin septations
  - Few, thin calcifications
  - Density: 15 HU

- **Category II**
Patient #2: JD, Bosniak Category III

- **US:**
  - Complicated cystic lesion with some solid-appearing elements among cystic spaces

- **CT:**
  - Multiple septations
  - Wall: moderate thickness
  - Minimal enhancement

**Category III**

**Nephrectomy: RCC**

Differential Dx of Renal Masses and Cysts

- Simple Cyst (Bosniak Cat. 1)
- Other Probable Benign Cysts
  - Infected cyst, minimally complicated cyst, hyperdense cyst (Bosniak Cat. 2), polycystic kidney disease
- Cystic Masses Possibly Assoc. w/ Malignancy
  - von-Hippel-Lindau, tuberous sclerosis, acquired cystic disease, multilocular cystic nephroma, (Bosniak Cat. 3 and 4)
- Definable Benign Solid Masses
  - Angiomyolipoma, hematoma, renal anomaly, infarction, lobar nephronia, xanthogranulomatous pyelonephritis
- Probable Malignant Solid Masses
  - RCC, transitional cell carcinoma, metastases, lymphoma, oncocytoma, etc.

Bosniak Classification System

Identifies:

- Lesions that do not require further work-up
  - Category I
  - Category II
- Lesions requiring radiologic follow-up
  - Category IIIF
- Lesions requiring invasive / surgical work-up
  - Category III
  - Category IV
Utility of Bosniak Classification System

Aronson et al. (1991)

– Retrospective review of CT/US findings in 16 pathologically proven renal cystic masses

- Cat. II lesions: All benign (4/4)
- Cat. III lesions: 3/7 benign, 4/7 malignant
- Cat. IV lesions: All malignant (5/5)

Utility of Bosniak Classification System

Wilson et al. (1996)

- Retrospective review of CT scans for 20 pts, 24 cystic renal masses biopsied or surgically removed

- Cat. I: All benign (7/7)
- Cat. II: 1/5 benign, 4/5 malignant
- Cat. III: All malignant (4/4)
- Cat. IV: All malignant (6/6)

Utility of Bosniak Classification System

Curry et al. (2000)

- Two-center, prospective and retrospective analysis of *properly performed* renal CT scans of 109 pts, 116 renal cystic lesions

- Cat. I and Cat. II: All benign (15/15)
- Cat. III: 29/49 malignant
- Cat. IV: All malignant (18/18)
- Prospectively followed patients: no malignancies

## Bosniak Classification System: Summary

<table>
<thead>
<tr>
<th>Study</th>
<th>Malignant Lesions</th>
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<td>Cat. III</td>
<td>Cat. IV</td>
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<td>Aronson et al.</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>6/39</strong></td>
<td><strong>50/98</strong></td>
<td><strong>69/76</strong></td>
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</table>

Conclusions

Renal cysts are commonly found on routine imaging.

By evaluating morphology, wall thickness, calcification, cyst attenuation, septations, and enhancement, it is possible to identify:

- Lesions that are benign
- Lesions that should be managed with radiologic follow-up
- Lesions that require biopsy or surgical excision
References

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