“Incidentalomas”
of Kidney Imaging

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Case Studies

• # 1 – A 62 year-old Man applies for Life insurance. He has blood in his HOS with 25 RBCs/HPF. His APS reveals that he c/o hematuria for about 6 months. A urologist report shows a consistent low to moderate amount of hematuria. He has had a negative cystoscopy, IVP, and renal ultrasound.

• # 2 – A 45 year-old woman applies for Life insurance. She appears healthy with routine OB/Gyn visits. Her family history reveals that her father had a renal transplant, but died of Polycystic Kidney Disease at the age of 65. Her gynecologist ordered a renal ultrasound when she was 42 years-old. It revealed 3 “simple” cysts bilaterally, all less than 2 CM. Her current insurance labs are normal.
Imaging the Kidney

- Review the Anatomy and Function
- Renal Mass
  - Cysts
  - Solid Mass
- Renal Parenchymal Disease
- Renovascular Disease
Imaging the Kidney

- **Plain X-ray Kidneys, ureters, and bladder (KUB)**
  - Can detect calcifications, may detect renal outline if visible
  - Should be only the starting point
- **Intravenous Urography (IVU) a.k.a. Intravenous Pyelography (IVP)**
  - 25-40 mg of iodine (75-150 ml) injected IV as a bolus

Taal; Brenner and Rector’s The Kidney, 9th ed.; Chapter 27 - Diagnostic Kidney Imaging

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Imaging the Kidney

- **Renal Mass**
  - IVP is not a sensitive test for renal Mass
  - Ultrasound is a little better
  - Compared to Computed Tomography (CT)

<table>
<thead>
<tr>
<th>Mass Size</th>
<th>IVP detects</th>
<th>Ultrasonography</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 cm</td>
<td>10%</td>
<td>26%</td>
</tr>
<tr>
<td>1-2 cm</td>
<td>21%</td>
<td>60%</td>
</tr>
<tr>
<td>2-3 cm</td>
<td>52%</td>
<td>82%</td>
</tr>
<tr>
<td>&gt;3 cm</td>
<td>85%</td>
<td>85%</td>
</tr>
</tbody>
</table>
Imaging the Kidney – Renal Cysts

- Renal cysts – found incidentally
  - Quite common – Most persons age 60+ will have one or more, found in 50% of people over age 50
  - Rare in those under age 25
  - Usually cortical in location
  - If seen on IVP, Ultrasound (US) is a good follow-up test to characterize
  - If a cyst has septa or internal echoes, a CT or MRI is warranted to evaluate

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<p>|</p>
<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Risk of malignancy</th>
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</thead>
<tbody>
<tr>
<td>Bosniak I</td>
<td>Round or oval, thin walled, no septations, 0-20 Hounsfield CT Units, no enhancement with IV contrast</td>
<td>Benign</td>
</tr>
<tr>
<td>Bosniak II</td>
<td>As above with a few septations and/or a few calcifications</td>
<td>Very low risk, f/u 6-12 months</td>
</tr>
<tr>
<td>Bosniak III</td>
<td>Thick wall, calcifications, Hounsfield density 0-20, no enhancement or nodules</td>
<td>60% chance</td>
</tr>
<tr>
<td>Bosniak IV</td>
<td>Thick wall, thick septations, coarse calcifications, Hounsfield Units &gt;20, enhance with contrast</td>
<td>Consider malignant, proceed with work-up</td>
</tr>
</tbody>
</table>

Taal: Brenner and Rector's The Kidney, 9th ed.; Chapter 27 - Diagnostic Kidney Imaging
Imaging the Kidney – Renal Cysts

- Complex cysts contain blood or proteinaceous material, may have density of 50-80, still have thin walls and no nodules
- Magnetic Resonance Imaging (MRI) may be superior to CT, especially with subtraction techniques, in differentiating complex cysts from cystic neoplasm

Complex structure with Septations
T1 weighted

Gadolinium, does not enhance
Needle aspirated – hemorrhagic cyst

Taal: Brenner and Rector’s The Kidney, 9th ed.; Chapter 27 - Diagnostic Kidney Imaging

Imaging the Kidney

- Autosomal dominant polycystic kidney disease (APCKD)
  - Accounts for 6-10% of patients on dialysis in the US
  - Begins in the 3rd or 4th decade
  - Pain in the flank, back, or abdomen is the most common complaint
  - If no change in the kidneys or early cysts by age of 19 – unlikely affected
  - If no findings by age 40 – extremely unlikely to be affected

Sonography
CT T2 weighted
Polycystic Kidney Disease

<table>
<thead>
<tr>
<th>AGE (YR)</th>
<th>Family Genotype</th>
<th>PKD1</th>
<th>PKD2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>REVISED CRITERIA FOR POSITIVE DIAGNOSIS</td>
<td>PPV</td>
<td>SEN</td>
</tr>
<tr>
<td>15-29</td>
<td>≥ 3 cysts, unilateral or bilateral</td>
<td>100</td>
<td>81.7</td>
</tr>
<tr>
<td>30-39</td>
<td>≥ 5 cysts, unilateral or bilateral</td>
<td>100</td>
<td>95.5</td>
</tr>
<tr>
<td>40-59</td>
<td>≥ 2 cysts in each kidney</td>
<td>100</td>
<td>90.0</td>
</tr>
<tr>
<td>≥ 60</td>
<td>≥ 4 cysts in each kidney</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGE (YR)</th>
<th>FAMILY GENOTYPE</th>
<th>NPV</th>
<th>SPEC</th>
<th>NPV</th>
<th>SPEC</th>
<th>NPV</th>
<th>SPEC</th>
</tr>
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<tbody>
<tr>
<td>15-29</td>
<td>≥ 1 cyst</td>
<td>90.8</td>
<td>97.1</td>
<td>99.1</td>
<td>97.6</td>
<td>83.5</td>
<td>96.6</td>
</tr>
<tr>
<td>30-39</td>
<td>≥ 1 cyst</td>
<td>98.3</td>
<td>94.8</td>
<td>100</td>
<td>96.0</td>
<td>96.8</td>
<td>93.8</td>
</tr>
<tr>
<td>40-59</td>
<td>≥ 2 cysts in each kidney</td>
<td>100</td>
<td>98.2</td>
<td>100</td>
<td>98.4</td>
<td>100</td>
<td>97.8</td>
</tr>
</tbody>
</table>


Imaging the Kidney

- **Benign Solid Renal Mass**
  - Renal adenoma is the most common benign neoplasm
    - Corticomedullary in location
    - Almost always < 2-3 cm in size
    - Demonstrate uniform enhancement on CT
  - Hamartomas (angiomyolipomas)
    - Solitary unilateral in women aged 30-50, often painful
    - Multiple, bilateral in those with tuberous sclerosis
    - The presence of Fat in the lesion ensures the diagnosis
    - < 4cm can be monitored, with surgery for symptoms or hemorrhage
  - Oncocytoma
    - Uncommon, benign tumor originating from the epithelium in the proximal collecting tubule
    - Oncocytic renal cell carcinomas occur, and surgery is usually needed to make the diagnosis
  - Fibromas, Myomas, Lipomas, and Hemangiomas are other uncommon, benign tumors of the kidney
Imaging the Kidney

• Renal Malignancy
  – Renal Cell Carcinoma
    • 85% of primary renal malignancies
    • Usually occurs in the 6th decade, male: female ~ 2:1
    • Flank pain, hematuria and flank mass seen in ~ 10%
    • Persistent, painless hematuria with negative cystoscopy and IVP needs to have a CT or MRI of the kidneys

DIFFERENTIAL DIAGNOSIS OF CHRONIC RENAL PARENCHYMAL DISEASE

• No papillary/calyceal abnormality
• Diffuse parenchymal loss
• Focal parenchymal loss

A. Bilateral
  – Chronic glomerulonephritis
  – Diffuse small-vessel disease
  – Hereditary nephropathies
  – Infarct
  – Previous trauma

B. Unilateral
  – Renal artery stenosis
  – Post irradiation
  – Rare:
    • Hypoplastic kidney
    • Postobstructive atrophy

Adam: Grainger & Allison’s Diagnostic Radiology, 5th ed.; CHAPTER 39
Renal Parenchymal Disease, including Renal Failure, Renovascular Disease and Transplantation
Imaging the Kidney

- **Papillary/calyceal abnormality**
  - Diffuse parenchymal loss
    - Obstructive nephropathy
    - Generalized reflux nephropathy
- **No Parenchymal Loss**
  - Papillary necrosis
  - Tuberculosis
  - Medullary sponge kidney
  - Megacalyses
  - Pelviccalyceal cyst
- **Focal Parenchymal Loss**
  - Focal reflux nephropathy (chronic atrophic pyelonephritis)
  - Tuberculosis
  - Calculus disease

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Renal Parenchymal Disease, including Renal Failure, Renovascular Disease and Transplantation

Chronic pyelonephritis, dilated calyces, thinned cortex, calcifications, and surrounding inflammation

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Renal Parenchymal Disease, including Renal Failure, Renovascular Disease and Transplantation
The most common cause of renal artery stenosis is atherosclerosis (70–80%).
It occurs most often in men over the age of 50 with risk factors for vascular disease.
It usually involves the origin (ostial) or the proximal third of the renal artery.
Plaques within the aorta often cause ostial lesions.
Eccentrically placed atheromatous plaques in the proximal renal artery may also be seen.
If the kidney is small or there are distal plaques, there may be little benefit to intervention.

Fibromuscular dysplasia (FMD) is the 2nd most common cause of renal artery stenosis (15-20%).
FMD typically occurs in young women, and should be investigated in a young person with hypertension.
It is a heterogeneous group of conditions, with medial fibroplasia the commonest form.
There are multiple short stenoses and is seen as a ‘string of beads’ in the distal main artery and major branches, and may be bilateral.
Medial fibroplasia dilates easily at lower pressures with excellent long-term results, while the other types, characterized by smooth stenoses, do not always dilate satisfactorily.
Imaging the Kidney

• Renal artery aneurysms are rare
  – They can be congenital, mycotic, post-traumatic, atherosclerotic, vasculitic or associated with FMD
  – Treat if causing hypertension or if there is a risk of rupture
  – Risk of rupture
    • aneurysm size (> 2.5 cm)
    • the absence of calcification
    • an association with pregnancy.
  – If the aneurysm is at risk of rupture, selective renal arteriography will be necessary to plan the appropriate treatment

• Renal infarction is usually due to thromboembolic occlusion of a renal artery
  – Principal source is atrial fibrillation
  – Others: aortic aneurysm, atheroma, vasculitis or trauma.
  – Clinical presentation: with pain and hematuria
  – Over time, the infarcted area decreases in size, with cortical scar formation
  – In vasculitis there are multiple small infarcts with patchy or wedge-shaped areas of altered perfusion

Case Studies

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• # 2 – A 45 year-old woman applies for Life insurance. She appears healthy with routine OB/Gyn visits. Her family history reveals that her father had a renal transplant, but died of Polycystic Kidney Disease at the age of 65. Her gynecologist ordered a renal ultrasound when she was 42 years-old. It revealed 3 “simple” cysts, 2 in the left, 1 in the right, all less than 2 CM. Her current insurance labs are normal. Consider a current renal US as cysts tend to increase in size and number over a period of years.

An early finding in APCKD is the inability to concentrate urine. Consider a urine specimen after a night of fasting/NPO – Specific Gravity < 1.015?