Management of the Incidental Renal Mass

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Silverman Disclosures

Consultant, Siemens Medical Solutions, Malverne, PA

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Learning Objectives

• To present a practical, medically appropriate approach to the incidental renal mass
Incidental Renal Masses

- are almost always benign
- their evaluation may lead to unnecessary costly tests and potentially morbid treatments.

However...
Incidental Renal Masses

- Most RCC is diagnosed via an incidental finding
- RCC is curable only when locally-confined

Hence, the challenge...
Cancer Incidence

Rates are per 100,000 and age-adjusted to the 2000 US population

Not solely due to imaging

Tobacco use, obesity…

Radiologist’s Goals

- Diagnose RCC at a curable stage
- Diagnose benign cysts and neoplasms to prevent unnecessary testing, surgeries, and ablations
- Suggest a medically appropriate, practical strategy for managing indeterminate renal masses
Radiologist’s Goals

Diagnosis + Recommendations = Management
Outline

• Approach; is it neoplastic?
• Cystic mass diagnosis
• Solid mass diagnosis
• Recommendations for cystic and solid masses in the general population and patients with limited life expectancy
Differential Diagnosis

Consider...

Pseudotumors
Vascular abnormality
Inflammatory
Traumatic

Before considering...

Cyst-like
Solid
## Cystic Renal Masses
*(after Bosniak)*

<table>
<thead>
<tr>
<th>Cat</th>
<th>Term</th>
<th>Prob %</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Simple, benign</td>
<td>0</td>
<td>proven</td>
</tr>
<tr>
<td>II</td>
<td>Complic, benign</td>
<td>@0</td>
<td>variable</td>
</tr>
<tr>
<td>IIF</td>
<td>Probably benign</td>
<td>?</td>
<td>Israel</td>
</tr>
<tr>
<td>III</td>
<td>Indeterminate</td>
<td>50</td>
<td>Aronson</td>
</tr>
<tr>
<td>IV</td>
<td>Malignant</td>
<td>&gt;95</td>
<td>Curry</td>
</tr>
</tbody>
</table>

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Israel AJR 03
Aronson Urol Rad 91
Curry AJR 91
Bosniak MA Radiology 1991
Category I Cyst

- Well-margined
- Water attenuation (0-20 HU)
- Non-enhancing
- Hair-line thin wall

Benign simple cyst

Ignore
Category II Cyst

- Thin and few septa
- Small, border-forming calcification

Benign complicated cyst

Ignore
**Category II Cyst**

Small ($\leq 3\text{cm}$), homogeneously hyperdense, typically 40-90 HU, and nonenhancing.

Hyperdense cyst

Ignore
Hyperdense on NCCT

• Renal masses with CT attenuation $\geq 70$ HU were benign hyperdense cysts in 99% of cases.

• It may be prudent to presume renal masses with CT attenuation $\geq 70$ HU are benign.

Jonisch et al Radiology 2007
Category II-F Cyst

- Multiple (more than a few), thin septa, with perceived enhancement
- Thick / nodular calcification

Benign multilocular cyst

Follow at 6, 12, and q12 mo to 5 yrs

Interval and duration may be varied

Israel and Bosniak AJR 2003
Benign multilocular cyst

Category III Cyst

- Multiple and thick, enhancing septa; thick wall
- Thick / nodular calcification
- Large, hyperdense

Benign multilocular cyst

Surgery
Cystic Renal Masses – Bosniak applied to MRI

- Of 69 cystic masses, MR identified more septa in 8 (12%) masses and thicker walls or septa in 7 (10%) compared with CT.

- In 2 (3%) masses, enhancement was different.

- MR upgraded 7 masses: II to IIF in 2, IIF to III in 3, and III to IV in 2.

Israel and Bosniak Radiology 2004
Cystic Renal Masses – Bosniak applied to MRI

- MRI may show enhancement not seen at CT
- MRI may correct pseudoenhancement at CT
- MRI may miss calcifications

MRI most helpful:
Category IIIF and III lesions
Confirm minimal (<1 cm) cystic masses as simple...
Category IV Cyst

- Nodular / soft-tissue enhancement
- Particularly when apart from wall

Cystic RCC

Surgery
Size and Growth...cystic

- Growth is not necessarily predictive (and not part of the Bosniak classification) – Benign cysts grow; cancerous ones may grow little, if at all.
- The smaller the mass, the more likely it is benign.

Silverman SG et al, Radiology 2008
### BWH Renal Mass CT Protocol

**64 Channel MDCT with 3 phases**

<table>
<thead>
<tr>
<th></th>
<th>Unenhanced</th>
<th>Nephrographic</th>
<th>Excretory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>Kidneys</td>
<td>Kidneys</td>
<td>Abd/Pel</td>
</tr>
<tr>
<td><strong>Delay</strong></td>
<td>--</td>
<td>100 s</td>
<td>8 min</td>
</tr>
<tr>
<td><strong>Collimation</strong></td>
<td>1.2 mm</td>
<td>1.2 mm</td>
<td>0.6 mm</td>
</tr>
<tr>
<td><strong>Axial Recon/Incr</strong></td>
<td>3/3</td>
<td>3/1.5</td>
<td>3/3</td>
</tr>
<tr>
<td><strong>Post Processing</strong></td>
<td>--</td>
<td>--</td>
<td>Coronal</td>
</tr>
</tbody>
</table>

Iodinated contrast material (300 mgI/ml); 0.5 s rotation time
165-200 mAs, 120 kVp
Renal Masses with MDCT

- Of 44 masses between 5 and 10 mm, 13 (30%) were characterized as cysts on 5/5 mm images, whereas 39 (89%) were characterized as cysts on 3/1.5 images.

Jinzaki et al, AJR 2004
Minimal (<1cm) renal lesion?

**Renal Mass Protocol CT or MRI**

- Use thin-sections to characterize lesions ≥ 5 mm as simple cysts; presume cystic lesions < 5 mm benign

**Non Renal Mass Protocol CT or MRI**

- Presume simple-appearing cystic lesions < 1 cm benign

Bosniak and Rofsky, Radiology 1996

Silverman SG et al, Radiology 2008
What is too small to characterize?

TSTC Definition relates to technique!

Section thickness \( \leq \frac{1}{2} \text{ lesion diameter} \)

Section thickness \( > \frac{1}{2} \text{ lesion diameter} \)

Lesion diameter \( < 2 \times \text{section thickness} \)
"3 mm cystic renal mass that is too small to diagnose definitively; it is statistically likely to be a benign simple cyst."

Bosniak and Rofsky, Radiology 1996
Silverman SG et al, Radiology 2008
How about this mass?

How do we report this finding?

Dense, but is it solid?

44% of solid masses < 1cm were benign

Frank et al J Urol 2003

S/P LUP partial nephrectomy /RCC
Solid Renal Mass < 1cm

Radiology Report...

Detected on enhanced CT

“7mm dense left-sided renal mass that could represent either a proteinaceous cyst or a small neoplasm such as a renal cell carcinoma or a benign neoplasm. Renal mass protocol is recommended in 3-6 mos.

Silverman SG et al, Radiology 2008
Solid Renal Mass < 1cm

Radiology Report...

Detected on renal mass protocol CT

“7mm enhancing left-sided renal mass that could represent either a small renal cell carcinoma or a benign neoplasm. If it is a small renal cancer, it could be indolent and a 3-6 mo f/u CT scan is suggested.”

Silverman SG et al, Radiology 2008
DDX - Solid Renal Mass

Malignant:

- Renal cell carcinoma (+ other rare types)
- Metastasis
- Lymphoma / Leukemia
- Sarcoma
- Wilms’ tumor
- Urothelial (TCC)
<table>
<thead>
<tr>
<th>Benign:</th>
<th>Many small, solid renal masses are benign!</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Adenoma)</td>
<td></td>
</tr>
<tr>
<td>Oncocytoma</td>
<td></td>
</tr>
<tr>
<td>Angiomyolipoma</td>
<td></td>
</tr>
<tr>
<td>JGA neoplasms</td>
<td>The smaller the solid mass, the more likely it is benign…</td>
</tr>
<tr>
<td>Leiomyoma</td>
<td></td>
</tr>
<tr>
<td>Fibroma</td>
<td></td>
</tr>
</tbody>
</table>
Solid Masses may be benign

- Of 2,770 nephrectomies /NSS for “solid” renal masses, 1977-2000
  - 12.8% benign
  - Masses < 3 cm  25% benign
  - Masses < 2 cm  30% benign
  - Masses < 1 cm  44% benign

Frank et al J Urol 2003
Solid Masses may be benign

<table>
<thead>
<tr>
<th>Benign Tumors resected</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oncocytoma</td>
<td>73</td>
</tr>
<tr>
<td>Angiomyolipoma</td>
<td>18</td>
</tr>
<tr>
<td>Papillary adenoma*</td>
<td>4</td>
</tr>
<tr>
<td>Not otherwise specified</td>
<td>4</td>
</tr>
<tr>
<td>Metanephric adenoma</td>
<td>1</td>
</tr>
</tbody>
</table>

*Papillary RCC <5mm

Frank et al J Urol 2003
Renal Oncocytoma

- Homogeneous
- Densely enhancing
- Central scar

Features NOT pathognomonic
Angiomyolipoma

- ≤ -10 HU is virtually pathognomonic
- Must be lesion ROI
- Non-calcified
## MRI Features of Renal Masses

<table>
<thead>
<tr>
<th>T1</th>
<th>T2</th>
<th>CE</th>
<th>Dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>dark</td>
<td>bright</td>
<td>+</td>
<td>RCC (CC type)</td>
</tr>
<tr>
<td>dark</td>
<td>dark</td>
<td>+</td>
<td>RCC (papillary)</td>
</tr>
<tr>
<td>dark</td>
<td>dark</td>
<td>+</td>
<td>AML w/ min fat</td>
</tr>
</tbody>
</table>
AML with Minimal Fat

- Approximately 4-5% AML contain little or no fat and are small, hyperdense, and homogeneously enhancing masses.
- Only 2% of RCC are hyperdense and homogeneously enhancing.

Jinzaki et al. Radiology 1997
RCC – typically papillary, or clear cell sub-type that has bled

Angiomyolipoma with minimal fat

Oncocytoma

Lymphoma

Metanephric adenoma (rare)

Leiomyoma (rare)

Metastases (rare)

Fat cells (FC) vs. Intracytoplasmic Lipid (ICL)

<table>
<thead>
<tr>
<th></th>
<th>Kidney</th>
<th>RCC</th>
<th>AML</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td></td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>ICL</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
</tbody>
</table>

* Except case reports
CCRCC may suppress on OOPS

Do not use OOPS alone to diagnose AML!

D/T intracellular lipid

Dyer et al Radiology 2008
Renal Mass Biopsy

Emerging Indications

- Small, hyperdense, homogeneously enhancing renal masses
- Renal masses referred for ablation
- Indeterminate cystic renal mass (Bosniak Category III)
- Multiple solid renal masses

Silverman SG et al Radiology 2006
Size and Growth...Solid

- The smaller the mass, the more likely it is benign.
- Growth is concerning but **not** diagnostic of a malignancy.
- W/U lesions that grow to 1 cm
- Lack of growth may be useful indicator of a benign neoplasm, or at least of benign behavior.

Silverman SG et al, Radiology 2008
Better to observe them?

- Many (25%) small (< 3 cm) enhancing masses are benign (Frank et al, J Urol 2004)
- As many as 50% of kidneys at necropsy contain small solid nodules that are called “adenomas” but are indistinguishable from renal cell carcinoma (Xipell et al, J Urol 1971)
- Most small RCC are low grade and their clinical behavior indolent (Kassouf et al, J Urol 2004)
Better to observe them?

- Metastases are extremely rare in the absence of growth (Chawla et al, J Urol 2006)

- Positive surgical margins do not predict local recurrence following partial nephrectomy (Yossepowitch et al, J Urol 2008)

- RCC mortality is increasing, and unaffected by small RCC treatment (Hollingsworth et al, J NCI 2006)
RCC Incidence Increasing

\[ \bullet = < 2 \text{ cm}, \quad \triangle = 2 - 4 \text{ cm}, \quad \circ = > 4 - 7 \text{ cm}, \text{ and } \Delta = > 7 \text{ cm}. \]

Due to RCC 2-4 cm

RCC Surgeries Increasing

\[ \bullet = \text{<2 cm}, \quad \triangle = \text{2-4 cm}, \quad \circ = \text{>4-7 cm}, \quad \text{and} \triangle = \text{>7 cm}. \]

Renal Surgeries (including ablations)

...for RCC 2-4 cm

Hollingsworth et al J Natl Cancer Inst 2006
RCC Mortality Increasing

For all sizes, particularly RCC 4-7cm

Unaffected by small RCC treatment

Better to not observe them?

- Studies are retrospective
- Many followed lesions are not path proven; some may be benign tumors and therefore data do not reflect the true risk of following cancers
- Errors in measurements
- Rare cases of sudden growth over many years of stability (Siu et al Urologic Oncology 2006)
### Metastases in pts w/ Small RCC

**RCC Size (cm)** | No. | % metastases
--- | --- | ---
0.1 – 1.0 | 286 | 1.4
1.1 – 2.0 | 1,693 | 2.5
2.1 – 3.0 | 3,354 | 4.7
3.1 – 4.0 | 3,459 | 7.4

Nguyen NM, Gill IS J Urol 2009

Tumor size may not predict fully the risk of metastatic disease

- 24,253 pts; 1998-2003
- % treated tumors presenting w/ mets!
## Management Recommendations

### Incidental Cystic Renal Mass

<table>
<thead>
<tr>
<th>Cat</th>
<th>Term</th>
<th>Gen Pop’n</th>
<th>Co-morbid</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Simple, benign</td>
<td>Ignore</td>
<td>Ignore</td>
</tr>
<tr>
<td>II</td>
<td>Complic, benign</td>
<td>Ignore</td>
<td>Ignore</td>
</tr>
<tr>
<td>IIIF</td>
<td>Probably benign</td>
<td>Observe</td>
<td>Obs/Ign</td>
</tr>
<tr>
<td>III</td>
<td>Indeterminate</td>
<td>Surgery</td>
<td>Surg/Obs</td>
</tr>
<tr>
<td>IV</td>
<td>Malignant</td>
<td>Surgery</td>
<td>Surg/Obs</td>
</tr>
</tbody>
</table>

Silverman SG et al, Radiology 2008
### Management Recommendations

When a mass smaller than 1 cm has the appearance of a simple cyst, further work-up is not likely to yield useful information.

<table>
<thead>
<tr>
<th>Class</th>
<th>Term</th>
<th>Gen Pop</th>
<th>Morbid</th>
<th>Ignorable</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Simple, benign</td>
<td>Ignore</td>
<td>Ignore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Complic, benign</td>
<td>Ignore</td>
<td>Ignore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Probably benign</td>
<td>Observe</td>
<td>Obs/Ign</td>
<td></td>
<td></td>
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<td>Surgery</td>
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<td></td>
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</tr>
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<td>IV</td>
<td>Malignant</td>
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<td></td>
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Silverman SG et al, Radiology 2008
<table>
<thead>
<tr>
<th>Category</th>
<th>Term</th>
<th>Co-Morbidities</th>
<th>Management Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Simple, benign</td>
<td>Ignore</td>
<td>Ignore Ignore</td>
</tr>
<tr>
<td>II</td>
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<td>Ignore</td>
<td>Ignore Ignore</td>
</tr>
<tr>
<td>III</td>
<td>Indeterminate</td>
<td>Observe</td>
<td>Obs/Ign Observe</td>
</tr>
<tr>
<td>IV</td>
<td>Malignant</td>
<td>Surgery</td>
<td>Surg/Obs Surgery</td>
</tr>
</tbody>
</table>

Laparoscopic partial nephrectomy and percutaneous ablation may be helpful in patients with co-morbidities that might increase the risk of surgery, and in patients with limited life expectancy. Long-term (5 or 10 year) results of ablation are not yet known.

Silverman SG et al, Radiology 2008
# Management Recommendations: Incidental Solid Renal Mass

<table>
<thead>
<tr>
<th>Size</th>
<th>Dx</th>
<th>Recommend/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large (&gt; 3cm)</td>
<td>RCC</td>
<td>Surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rarely benign</td>
</tr>
<tr>
<td>Small (1-3cm)</td>
<td>RCC</td>
<td>Surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MRI/Biopsy if hyperdense</td>
</tr>
<tr>
<td>Very small</td>
<td>RCC</td>
<td>Observe</td>
</tr>
<tr>
<td>(&lt; 1cm)</td>
<td>AML</td>
<td>Use thin sections</td>
</tr>
<tr>
<td></td>
<td>Oncocytoma</td>
<td>until 1 cm</td>
</tr>
</tbody>
</table>

**General Population**

Silverman SG et al, Radiology 2008
### Incidental Solid Renal Mass

<table>
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<td>Use thin sections until 1 cm</td>
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</tbody>
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**Oncocytoma**

*Provided there is no detectable fat by CT or MRI using protocols designed to evaluate renal masses*

---

**General Population**

Silverman SG et al, Radiology 2008
## Management Recommendations

### Incidental Solid Renal Mass

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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>AML</td>
<td>until 1 cm</td>
</tr>
</tbody>
</table>

### General Population

Ablation may be considered but biopsy is needed to achieve a tissue dx. Long-term (5 or 10 year) results are not yet known.

Silverman SG et al, Radiology 2008
### Management Recommendations

**Incidental Solid Renal Mass**

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<td>Large (&gt; 3cm)</td>
<td>RCC</td>
<td>Surgery Rarely benign</td>
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<td>MRI/Biopsy if hyperdense</td>
</tr>
<tr>
<td>Very small (&lt; 1cm)</td>
<td>RCC</td>
<td>Observe Use thin sections</td>
</tr>
<tr>
<td></td>
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<td>until 1 cm</td>
</tr>
<tr>
<td></td>
<td>Oncocytoma</td>
<td></td>
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</tbody>
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**General Population**

Benign entities are more likely in small renal masses than large ones...

Silverman SG et al, Radiology 2008
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<td>RCC</td>
<td>Surgery/MRI/Biopsy</td>
</tr>
<tr>
<td>Small (1-3cm)</td>
<td>Oncocytoma</td>
<td>Hyperdense</td>
</tr>
<tr>
<td>Very small (&lt; 1cm)</td>
<td>RCC, AML</td>
<td>Observe, Use thin sections, until 1 cm</td>
</tr>
</tbody>
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<th>Size</th>
<th>Dx</th>
<th>Recommend/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large (&gt; 3cm)</td>
<td>RCC</td>
<td>Surgery or observe  Rarely benign Consider biopsy</td>
</tr>
<tr>
<td>Small (1-3cm)</td>
<td>RCC</td>
<td>Surgery or observe MRI/Biopsy if hyperdense</td>
</tr>
<tr>
<td>Very small (&lt; 1cm)</td>
<td>RCC</td>
<td>Observe Use thin sections  AML until 1.5 cm Oncocytoma</td>
</tr>
</tbody>
</table>

*Limited life expectancy/Co-morbidity*

Silverman SG et al, Radiology 2008
Important Caveats...

- These recommendations are best followed after non-neoplastic causes of a renal mass (e.g., infections) have been excluded.

- These recommendations are offered as general guidelines and do not necessarily apply to all patients.

Silverman SG et al, Radiology 2008