Management of the Incidental Renal Mass

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Disclosure(s)

Grant funding for studying dose and dose reduction methods in CT (Siemens Healthineers)
The problem? Renal masses are common ... and they are found on many different exams

Renal cysts are common
  • > 1600 CT patients – prevalence ~ 40%

Abdominal, non-urinary tract, exams
  • CT: NCCT only, CECT only, WO&W contrast
  • US: RUQ, AAA
  • MRI: Liver, pancreas, adrenal

Non-abdominal exams
  • CT: chest, lumbar spine
  • MR: spine, pelvic
Renal Cell Carcinoma is not nearly as common

Renal cell carcinoma
  • Estimated less than 4% of new cancer cases in 2017
  • Breast, lung, prostate, colon, melanoma, bladder CA and lymphoma are all more common

But, 2/3rds of RCC are incidental findings
  • Estimated 64,000 new cases in 2017
  • And when incidental, RCC survival rates are better
IFC algorithm is based (mostly) on the available imaging

5 figures now form the IFC algorithm (2 previously)

• Fig. 1 – unenhanced CT only
• Fig. 2 – contrast enhanced CT only (not phase specific)
• Fig. 3 – cystic renal masses on without & with contrast CT or MR
• Fig. 4 – solid renal masses on without & with contrast CT or MR
• Fig. 5 – if there is measureable fat attenuation (ROI < -10 HU)
3 possible conclusions from the imaging

1) Solid, simple or complicated cystic mass, and management can be recommended
   e.g. Bosniak cyst, enhancing neoplasm, AML

2) Needs further imaging before recommending management
   e.g. homogeneous hyperdense mass, solid mass versus hemorrhagic cyst
   e.g. heterogeneous mass, but cannot determine enhancement

3) Not formally characterized, BUT features are reliably benign, so no further imaging needed
   e.g. many benign cysts, many TSTC masses
Features considered for creating the algorithm

1. Size (largest dimension, follows staging)
2. Homogeneous or heterogeneous
3. Attenuation – multiple ROIs, not pixels
4. Enhancement
5. Cyst complexity (Bosniak classification)
6. Growth and morphologic changes
7. Potential utility of percutaneous biopsy
1. Renal mass size

- Higher potential for malignancy with larger sizes
  - ~40% masses < 1 cm are benign
  - ~20% masses 1 – 4 cm are benign
  - <10% masses > 4 cm are benign

- Major studies
  - Frank et al, *J Urology* 2003 ~ 2700 patients
  - Corcoran et al, *Urology* 2013 meta-analysis
    - 26 studies with over 12,000 patients

- More good news about small size – smaller cancers are indolent with a low risk of metastases
The “too small to characterize mass”

- Volume averaging of adjacent parenchyma or perinephric fat makes ROI HU measurements unreliable
  - TSTC = mass diameter less than twice slice thickness (i.e. 4 mm mass, 3 mm slice)
- Many / most can be assessed subjectively
  - Visibly much lower (NCCT or CECT) or much higher (NCCT only) than parenchyma... are **likely to be benign cysts** that need no further evaluation
  - Worst case? An indolent solid mass...
- **Reminder:** Problems due to volume average can be minimized by creating thin slices (≤ 1-1.5 mm)
TSTC? Assess subjectively: many are cysts

December 2014

January 2017
2. Renal mass features – Homogeneous

Homogeneous

- Thin or imperceptible wall
- No septa
- No mural nodule
- Similar average HU attenuation throughout
- No calcification
2. Renal mass features – Heterogeneous*

Heterogeneous*

- Thickened or nodular wall
- One or more septa
- Mural nodule(s)
- Measureable or visible attenuation differences
- Calcification

Use narrow windows, place several ROIs

Lobular cystic mass

ROI 22 HU & 53 HU
3 & 4. Attenuation and enhancement

**HU Density (ROIs)**
- < -10 contains fat
- -10 to +20 simple fluid
- >20 to +69 indeterminate
  - Blood or high protein conc.
  - Soft tissue
- ≥ +70
  - NCCT – hyperdense cyst
  - CECT – indeterminate

**Enhancement**
- Between pre & any post
- ≤ 10 HU - no enhancement
- > 10 – < 20 HU – equivocal
  - Consider size and location
  - Beam hardening
- ≥ 20 - enhancing
## 5. Cyst complexity related to likelihood of CA

<table>
<thead>
<tr>
<th>Bosniak Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Benign simple cyst with a hairline thin wall without septa, calcification or solid component. Homogeneous density (-10 to 20 HU) without enhancement.</td>
</tr>
<tr>
<td>II</td>
<td>Benign minimally complicated cyst, +/- few hairline thin septa, +/- ‘Perceived’ but not measurable enhancement. +/- Fine calcification or a segment of slightly thickened calcification in the wall or septa. Also, a well-marginated non-enhancing homogeneous mass ≤ 3 cm with density above simple fluid attenuation (hyperdense cyst).</td>
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<tr>
<td>IIIf</td>
<td>Usually benign complicated renal cyst with multiple hairline thin septa or minimal smooth thickening of the wall or septa. +/- Thick and nodular calcification. +/- ‘Perceived” but not measurable enhancement. Also, a well-marginated intra-renal non-enhancing mass &gt; 3 cm with density above simple fluid.</td>
</tr>
<tr>
<td>III</td>
<td>Indeterminate complicated cystic renal mass with thickened irregular walls or septa that have measurable enhancement.</td>
</tr>
<tr>
<td>IV</td>
<td>Malignant cystic renal neoplasm with enhancing soft tissue components.</td>
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<tr>
<td>(~ 12% malignancy rate)</td>
<td></td>
</tr>
<tr>
<td>(50-60% malignancy rate)</td>
<td></td>
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<tr>
<td>(&gt; 90% malignancy rate)</td>
<td></td>
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</tbody>
</table>
6. Growth / active surveillance data

• No / slow growth ≠ benign; either benign or indolent
• RCC rarely metastasizes in absence of growth
  • < 4 cm masses growth 0.28 cm/yr had less than 1% mets*
• Rapid growth is associated with higher rate of mets
  • Larger masses avg growth 2.8 cm/yr had ~14% develop mets**
• Note: Growth is not part of Bosniak classification
  • Look for change in morphology (increasing heterogeneity)

**Mues AC, et al. Urology 2010;76:620–3
Solid mass: No / minimal growth x 6 yrs

02.03.2017  12.17.2015  01.19.2011
Surveillance (or comparison with old exams)

Growth (solid masses)
• = greater than 3 mm/yr (average) over 5 years...
• Looking prospectively or retrospectively
• If there is definite growth, may continue surveillance, but referral for discussion is appropriate

Morphologic change
• Any change in the “heterogeneity”
  • Thicker wall
  • More septa
  • More density variation
  • New / enlarging mural nodule
7. Biopsy

**General concepts**
- Safe and effective
- Differentiate benign from malignant
- Assess metastatic potential (grade, histology)
- Guide management in patients with LLE, multiple co-morbidities, etc.

**Potentially benign**
- Masses 1 – 4 cm
- Possible fat-poor AML
  - Homogeneous & hyperdense on NCCT
  - Low signal on T2WI
  - Younger women(?)
Utility of MR compared with CT

Advantages
• Better tissue characterization
• No pseudoenhancement
• More sensitive for contrast enhancement

Uses
• Charactering small cystic renal lesions – T2 hyperintensity
• Assess enhancement in hypovascular renal masses

Recommend MR for small lesions (especially if ≤ 1.5 cm)
Utility of MR with $\leq 1.5$ cm lesions
MR shows more complexity, more septa
Potential change of Bosniak classification
Management does not necessarily mean surgery

- Management “options”
  - Extirpation (radical, total, or partial nephrectomy)
  - Ablation (surgical or percutaneous)
  - Biopsy
  - Surveillance

- Patients with limited life expectancy, poor surgical risk or severe co-morbidities?
  - May forgo further characterization or surveillance
  - Joint decision making with primary physician and urology
Inclusion / Exclusion for the Algorithm

• **Includes**
  - Incidental masses (no urinary tract clinical signs or symptoms)
  - Patients 18 years of age or older

• **Excludes**
  - Patients with medical conditions or genetic syndromes predisposing to renal neoplasms (e.g. vHL, Lynch syndrome)
  - Primary malignancy with reasonable likelihood of metastatic disease to the kidneys (e.g. lung, melanoma, lymphoma)
  - Infiltrating renal lesions
Remember to exclude...

- RA aneurysm
  - Peripheral rim ca++
- Abscesses
  - Check clinical sign/sxs
- Caliceal diverticuli
  - Use delayed images
- Obvious cancers!
Figure 1: Incidental renal mass on non-contrast CT
(Only unenhanced CT available, not completely characterized)
Does not contain fat

- **TSTC, homogeneous**
  - Likely benign cyst, not fully characterized
  - No further W/U
  - **Indeterminate**
    - WO&W MR (preferred) or WO&W CT within 6-12 months

- **Homogeneous**
  - **-10 to 20 HU**
    - Likely benign cyst, not fully characterized
    - No further W/U
  - **Indeterminate**
    - WO&W MR or WO&W CT
  - **21-69 HU**
    - Hemorrhagic or proteinaceous cyst, unlikely to be neoplastic
    - No further W/U
  - **≥ 70 HU**
    - Hemorrhagic or proteinaceous cyst, unlikely to be neoplastic
    - No further W/U

- **Heterogeneous**
  - Inconclusive based on subjective evaluation
  - **Indeterminate**
    - Recommend WO&W MR or WO&W CT
Hyperdense Bosniak II cyst

- Density on NCCT ≥ 70 HU – Bosniak II cyst
- Similar lesions TSTC - *visibly much higher* than unenhanced renal parenchyma – likely Bosniak II cysts
Heterogeneous mass on NCCT → WO&W CT
Figure 2: Incidental renal mass on contrast-enhanced CT
(Only contrast-enhanced CT available, not completely characterized)
Does not contain fat

- **TSTC, homogeneous**
  - Likely benign cyst not fully characterized
  - No further W/U

- **Homogeneous**
  - Inconclusive based on subjective evaluation

- **Heterogeneous**
  - > 20 HU
    - Solid or complicated cystic mass

- **Indeterminate**
  - WO&W MR (preferred) or WO&W CT within 6-12 months

- **Indeterminate**
  - Recommend WO&W MR or WO&W CT
Indeterminate lesion on CECT 55 HU

28-30 HU

56-59 HU
Figure 3: Incidental cystic renal mass (Completely characterized on CT or MRI without and with IV contrast)

- Does not contain fat

- **Bosniak I or II**
  - Benign simple (Bosniak I) or Minimally complicated (Bosniak II) cystic mass
  - No further W/U

- **Bosniak IIIF**
  - Surveillance: WO&W CT or WO&W MRI at 6 and 12 mo, then yearly for 5 yrs
  - No morphologic change
    - Benign complex cystic mass (Bosniak IIIF)
      - No further W/U
  - Morphologic change
    - Refer for management

- **Bosniak III or IV**

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**Note:** This decision tree is designed to guide the management of incidental cystic renal masses based on the Bosniak classification system.
Bosniak IIF

- Thickening of septa over 2 years – ccRCC (resected 2009)
Bosniak III cysts

Benign cystic nephroma (2 pts)

Cystic clear cell RCC
Figure 4: Incidental solid renal mass or Incidental mass too small to characterize (TSTC) (Evaluated on CT or MRI without and with IV contrast)
Does not contain fat

- TSTC
- Solid mass < 1.0 cm
- Solid mass 1.0 – 4.0 cm
- Solid mass > 4.0 cm

- Likely benign cyst
  - No further W/U

- Indeterminate
  - WO&W MR (preferred) or WO&W CT within 6-12 months

- Small renal neoplasm
  - Follow-up WO&W MR (preferred) or WO&W CT beginning at 6-12 months, then yearly for 5 yrs
  - Growth or Morphologic change
    - Small renal neoplasm
      - Refer for management; consider biopsy

- Stable
  - Unlikely clinical significance
    - No further W/U

- Inconclusive based on subjective evaluation
Small renal mass (1-4 cm)

- Solid enhancing mass ~ 2.2 cm
- Approximately 20% chance of being benign – fpAML, oncocytoma
- Refer for management - treat, follow, biopsy
Figure 5: Incidental renal mass containing fat
(Contains a region of interest measuring less than -10 HU)

No calcification
Angiomyolipoma (AML)

Solitary without documentation of growth

Size < 4 cm
Benign AML (ASx)
No further W/U

Size ≥ 4 cm
Or > 5 mm aneurysm
AML with potential for clinical symptoms

Multiple or growth based on old studies
Refer for management

With calcification
Suspected Renal Cell Carcinoma

CT or MR WO&W IV contrast
AML diagnosed by thin section NCCT

NP 3 mm slices  3-22 HU

NC  thin slices  -36 HU
Not included in the algorithm

**Dual-Energy CT**
- Virtual NC imaging or iodine map might be used to evaluate enhancement on CE scan
- Management as a fully characterized cystic or solid mass
- Data good but still emerging

**Contrast-enhanced US**
- Good data from outside the US
- Benign vs malignant tumor
- Confident diagnosis of no-vascular (cystic) masses
- Just recently approved in US

**PET-CT and PET-MRI**
- Limited role in evaluating incidental masses
- Not recommended
Summary

Features to consider
• Size (small renal masses)
• Heterogeneity vs homogeneity
• Attenuation values
• Enhancement (+10 to +20 equiv)
• Cyst complexity (Bosniak)
• Growth & morphologic change
• Role of biopsy

Disposition Options
• Indeterminate features, needs additional imaging
  • Renal mass CT or MR protocol
• Benign or highly likely benign
  • No further imaging
• Small potential malignancy
  • Surveillance for growth / change
• Enhancing solid mass > 1 cm
  • Refer for management
  • Consider biopsy 1-4 cm