Adrenal Masses: Benign or Malignant?

Erica McAuliffe,  Harvard Medical School Year III
Gillian Lieberman, MD

March 2002
Normal Adrenal Anatomy

Normal Adrenal CT

http://www.vh.org/Providers/Textbooks/LungTumors/CaseStudies/Patient004/Text/CTCompAdrenalMets.html
Normal Adrenal Histology

- Mineralocorticoids
- Glucocorticoids
- Sex Steroids
- Catecholamines

From http://www.vh.org/Providers/Textbooks/MicroscopicAnatomy/Section15/Plate15293.html
Why Look at Adrenals?

• Endocrine workup in a patient with suspicious symptoms or laboratory values
  – ie, hypertension, Cushingoid symptoms, virilism, adrenal insufficiency

• Looking for metastases in a patient with known extra-adrenal malignancy

• Post-trauma abdominal survey

• ANY reason for obtaining a scan of the abdomen
  – Incidental adrenal masses are detected in 0.35-4.4% of CT scans done for other reasons.
Menu of Tests for Evaluating Adrenals

1. **Plain Films**
   - Limited role; useful for calcifications

2. **Ultrasound**
   - Cyst vs. solid
   - Intra-operative use in laparoscopic adrenalectomies

3. **CT**
   - Procedure of choice for patients with known or suspected adrenal lesions
   - Attenuation values useful in differentiating pathology
4. **MRI**
   - Best test for suspected pheochromocytoma
   - Chemical shift imaging to determine fat content

5. **Radioisotope Scanning** = Functional imaging
   - $^{131}$I labeled cholesterol analog can detect functional adrenocortical tumors
   - Labeled guanethidine analog (MIBG) can detect functional adrenomedullary tumors
Differential Diagnosis of Adrenal Enlargement

- **BENIGN**
  - Adenoma - functional
  - Adenoma - nonfunctional
  - Adrenal hyperplasia
  - Pheochromocytoma (90%)
  - Myelolipoma

- **MALIGNANT**
  - 1° adrenal carcinoma
  - Metastasis
  - Ganglioneuroma
  - Neuroblastoma

- **OTHER**
  - Cyst
  - Hematoma/Hemorrhage
  - Infection
Our Patient W.W.

• Healthy 61 year old man.

• PMH: gout, appendectomy.

• 60 pack-year smoker, quit 13 years ago.

• CXR at outside hospital revealed LUL nodule.

• Referred to BIDMC for further evaluation.

• A chest CT was ordered.
Our Patient W.W. Chest CT

Lung Nodule
Patient W.W. – Chest CT Findings

- 1.6 x 1.7 cm spiculated nodule in peripheral aspect of LUL.
- Routine chest CT images include the upper abdomen and both adrenal glands.
Our Patient W.W.: CT Findings

Renal Mass
Patient W.W. - CT Findings

- **Lung nodule**: 1.6 x 1.7 cm spiculated nodule in peripheral aspect of LUL.
- **Renal mass**: Cystic and solid lesion off upper pole of R kidney, 6.1 x 4.5 cm, consistent with 1° RCC.
Our Patient W.W.: CT with contrast

Hemangioma

L adrenal mass:
Focal area of higher intensity
Patient W.W. - CT Findings

- **Lung nodule**: 1.6 x 1.7 cm spiculated nodule in peripheral aspect of LUL.
- **Renal mass**: Cystic and solid lesion off upper pole of R kidney, 6.1 x 4.5 cm, consistent with 1° RCC.
- **Liver lesion**: 3.2 cm lesion in caudate lobe, consistent with hemangioma.
- **L adrenal mass**: Well-circumscribed, fat-containing 1.9 x 1.5 cm mass.
Our Patient W.W.:
CT with contrast - R adrenal gland

Lobular areas of decreased attenuation
Patient W.W. - CT Findings

- Lung nodule: 1.6 x 1.7 cm spiculated nodule in peripheral aspect of LUL.
- Renal mass: Cystic and solid lesion off upper pole of R kidney, 6.1 x 4.5 cm, consistent with 1° RCC.
- Liver lesion: 3.2 cm lesion in caudate lobe, consistent with hemangioma.
- L adrenal mass: Well-circumscribed, fat-containing 1.9 x 1.5 cm mass.
- R adrenal mass: Lobular areas of decreased attenuation
Adrenal Metastases

- Common; can alter treatment options.
- Most common primary sites:
  - Lung
  - Breast
  - Kidney
  - Bowel
  - Ovary
  - Melanoma
- 90% of adrenal masses found in SC lung cancer patients are mets.
- 60% of adrenal masses found in NSC lung cancer patients are mets.
### Benign vs. Malignant?

<table>
<thead>
<tr>
<th></th>
<th>Benign Adenoma</th>
<th>Metastasis</th>
<th>1° Adrenal Carcinoma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>Small (&lt; 5cm)</td>
<td>Variable, can be bilateral</td>
<td>Often &gt;5cm when detected</td>
</tr>
<tr>
<td><strong>CT</strong></td>
<td>-Well-defined, -no calcifications, -no hemorrhages &lt; 10 HU</td>
<td>-Heterogenous, -Indistinct margins</td>
<td>-Heterogenous, -Necrosis and hemorrhage common</td>
</tr>
<tr>
<td><strong>MRI</strong></td>
<td>-Low SI -In-phase/out-of-phase shows drop in SI</td>
<td>-Higher SI than adenoma -No SI drop out on chemical shift MRI</td>
<td>-Hyperintense</td>
</tr>
</tbody>
</table>
Intracellular Lipid Content

Adrenal Carcinoma  Normal Cortical Tissue
### Benign vs. Malignant?

<table>
<thead>
<tr>
<th>Size</th>
<th>Benign Adenoma</th>
<th>Metastasis</th>
<th>1° Adrenal Carcinoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>-Well-defined, -no calcifications, -no hemorrhages &lt; 10 HU</td>
<td>-Heterogenous, -Indistinct margins</td>
<td>-Heterogenous, -Necrosis and hemorrhage common</td>
</tr>
<tr>
<td>MRI</td>
<td>-Low SI -In-phase/out-of-phase shows drop in SI</td>
<td>-Higher SI than adenoma -No SI drop out on chemical shift MRI</td>
<td>-Hyperintense</td>
</tr>
<tr>
<td>Size</td>
<td>Small (&lt; 5cm)</td>
<td>Variable, can be bilateral</td>
<td>Often &gt;5cm when detected</td>
</tr>
</tbody>
</table>
MRI Signal Intensity

Primary Adrenal Carcinoma: Patient #2

CT Features:
- Large size
- Calcification
- Extension into liver
- Heterogenous, cystic and solid

From Kaplan, N. The adrenal incidentaloma. *Up to Date* 10.1., 2002.
Patient W.W. –
CT scan without contrast

L ADRENAL MASS
HU = -5 to +4
Patient W.W.: CT with contrast
Chemical Shift MRI

• Fat protons and water protons have different resonance frequencies.

• At a known time interval, the protons are out-of-phase, and their signals cancel out.

• By timing images based upon this interval, we can determine the fat content of a certain tissue.
Chemical Shift MRI – Example of Mets

IN-PHASE

OUT-OF-PHASE

No loss of signal intensity indicates no intracellular fat.

Patient W.W.: Chemical Shift MRI of R adrenal mass

Loss of signal intensity indicates presence of intracellular lipid.
Patient W.W.: Chemical Shift MRI of L adrenal mass

Signal intensity decreases, except for small central focus.
Our Patient W.W., cont.

- Uncertainty persisted after CT and MRI.
- Percutaneous biopsy done of L adrenal gland.
- Pathology revealed **benign L adrenal adenoma**.
- Left upper lobectomy performed --> pathology revealed adenocarcinoma of lung.

- Right nephrectomy and adrenalectomy performed --> revealed renal cell carcinoma and... **R adrenal myelolipoma**.
Adrenal Myelolipomas: Patient #3

- Benign tumors composed of adipose and hematopoietic tissue.

- Radiographic features:
  - Macroscopic fat (low attenuation)
  - May enhance with contrast administration
  - 20% calcify

- No treatment required.

Algorithm for incidental adrenal mass

Adrenal mass

Not hyperfunctioning → Biochemistry

Size

> 3cm → Biopsy or surgery

≤ 3cm → Non-contrast CT → CT attenuation value

HU < 10 → Benign adenoma
HU > 10 → Chemical-shift MRI or biopsy

EITHER

Functioning → Surgery

Chemical-Shift MRI → Signal intensity

Loss → Benign adenoma
No loss → Biopsy or surgery

Differential Diagnosis of Adrenal Enlargement

• **BENIGN**
  – Adenoma - functional
  – Adenoma - nonfunctional
  – Adrenal hyperplasia
  – Pheochromocytoma (90%)
  – Myelolipoma

• **MALIGNANT**
  – 1° adrenal carcinoma
  – Metastasis
  – Ganglioneuroma
  – Neuroblastoma

• **OTHER**
  – Cyst
  – Hematoma/Hemorrhage
  – Infection
References

• Bergman, RA, AK Afifi, PM Heidger, University of Iowa, 2001: http://www.vh.org/Providers/Textbooks/MicroscopicAnatomy/Section15/Plate15293.html

• Busick, NP, PC Fretz, JR Galvin, MW Peterson, and CE Platz, Univ. of Iowa, 2000: http://www.vh.org/Providers/Textbooks/LungTumors/CaseStudies/Patient004/Text/CTCompAdrenalM ets.html


• Kaplan, NM. The adrenal incidentaloma. UpToDate, online 10.1. 2002.


Acknowledgments

• Damon Soiero, MD
• Haldon Bryor, MD
• Jonathan Kruskal, MD
• Gillian Lieberman, MD
• Pamela Lepkowski
• Webmasters Larry Barbaras and Cara Lyn D’amour