Radiology report

<table>
<thead>
<tr>
<th>58 yom with hypertension and vague abdominal pain gets a CT that shows an incidental 2.5 cm adrenal nodule. Dedicated adrenal CT recommended.</th>
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<tbody>
<tr>
<td>Do you need the extra CT?</td>
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<tr>
<td>Anything to worry about?</td>
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</tbody>
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Adrenal Incidentalomas

- 6% (1-32%) of individuals have adrenal adenomas on autopsy
- 4% of individuals have adrenal incidentalomas on CT
- Prevalence increases with age
  - < 1% age < 30
  - 7% age > 70

3-10 million Americans!

Common Adrenal Masses

- Adrenalocortical Adenoma 90+%  
- Pheochromocytoma 5%  
- Adrenalocortical Carcinoma <5%?  
- Metastatic Lesion 2.5%

Incidence of carcinoma 3000/year  
Corresponding prevalence 1/1000 (0.1%)  
Prevalence really 5%?

Why Adrenal Specific CT

1. Thin cuts (2-3 mm) through the adrenals which are quite small.  
2. Determine pre contrast Hounsfield Units (HU)  
   • HU < 10-15 very specific for benign adenoma  
3. Determine % washout of contrast  
   • Washout % > 60 is very specific for benign adenoma

Adrenal Nodule – Imaging

- Concerning features  
  • Hemorrhage, Calcification, Necrosis  
  • no fat (high HU)  
- Concerning size  
  • > 4 cm : 70% malignant (excluding adrenal myelolipomas and pheochromocytomas)  
  • > 6 cm : 85% malignant

58 yom with hypertension and vague abdominal pain gets a CT that shows an incidental 2.5 cm adrenal nodule. Dedicated adrenal CT recommended.

**IMPRESSION:**
1.3 cm nodule in the left adrenal gland. This has Hounsfield units and enhancement characteristics consistent with a benign adrenal adenoma. No additional follow-up is recommended.

### What to do?

1) Wish you hadn’t ordered the original CT in the first place.
2) Be thankful everything is good and tell the patient it’s nothing to worry about.
3) Wish you hadn’t gone to that CME course in Hawaii as now you know #2 isn’t correct and you have more work ahead.

#### Adrenal Gland - Hormones

- **Catacholamines (Medulla)**
  - Pheochromocytoma
- **Mineralocorticoids (aldosterone/glomerulosa)**
  - Aldosterone secreting adenoma
  - Adrenal hyperplasia
  - Adrenal carcinoma
- **Glucocorticoids (cortisol/fasiculata)**
  - Adrenal adenoma
  - Adrenal carcinoma
  - Bilateral hyperplasia
- **Androgens (DHEA/reticularis)**
  - Adrenal carcinoma

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1+ %?
5- %?
### Common Adrenal Masses

- Adrenocortical Adenoma 90+%  
  - Aldosterone secreting 1%?  
  - Cortisol secreting 5%?  
- Pheochromocytoma 5%  
- Adrenocortical Carcinoma < 5%?  
- Metastatic Lesion 2.5%

### Hormonal Evaluation

- Everyone:  
  - Dexamethasone suppression test  
    - 1 mg dex at 11-MN night before with 8 am cortisol  
    - Cortisol > 5 mcg/dl is abnormal  
  - Fractionated urinary metanephrines and catecholamines or plasma metanephrines  
- If Hypertension  
  - Hyperaldo screening test with morning plasma aldosterone and plasma renin activity  
    - Ratio > 20 AND aldo > 15 consider hyperaldo

### Endocrine Referral

66 yow with DM2, HTN on a beta-blocker, HCTZ, and amlodipine. Got aldo and renin because K was 3.4. Elevated ratio. Abdominal CT with 1.4 cm adenoma on left. Please assist in referral to surgery.

**LABS**

- Aldo 4  
- PRA 0.1  
- Aldo/PRA ratio: 40 H (nl < 20)

*Patient with hypoaldo, hyporenin state due to age and DM2. Ratio is high (low renin). Aldo is not high. Now there is the need to w/u the incidental nodule.*

### Primary Hyperaldosteronism - Etiologies

- Steady rise in prevalence (5-10% of hypertensive patients?)  
- Adrenal adenoma (75%)  
  - usually very small tumors  
  - treat/cure with surgical resection  
- Bilateral adrenal hyperplasia (25%)  
  - treat medically with aldosterone antagonist (spironolactone or eplerenone)  
- Adrenal carcinoma (rare%)  
  - very, very poor prognosis, more often secrete DOC, mineralocorticoid excess least of concerns
### Effect of Antihypertensives on Aldo-Renin Ratio

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Effect on Renin</th>
<th>Effect on aldosterone</th>
<th>Effect on Aldo/PRA ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE-inhibitors</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ARB</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Diuretics</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Calcium Channel Blockers</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>β-blockers</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ca++ Antagonists</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aldosterone Antagonists</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Confirmatory Tests for Hyperaldo

- **Screening test**: Elevated Aldo/PRA ratio
- **Confirmatory Tests**
  - 24 hour urine aldosterone testing after a salt load
  - Saline suppression test
  - Fludrocortisone suppression test
  - Captopril (ACE-I) challenge test

### Problems with Testing in Hypertensive Patients

- Stopping BP meds
- Massive salt loading

### Once confirmed need to consider need for adrenal vein sampling

### DIAGNOSING ENDOCRINE DISORDERS

1. Discern a clinical syndrome
2. Make the biochemical diagnosis of hormone excess or deficiency
3. Determine the etiology of the hormone excess or deficiency
4. Consider appropriate imaging to localize the site of pathology
Radiology report
58 yom with hypertension and vague abdominal pain gets a CT that shows an incidental 2.5 cm adrenal nodule. Dedicated adrenal CT recommended.

IMPRESSION:
Indeterminate 15 mm nodule in left adrenal gland. For further evaluation a biopsy is recommended if clinically indicated.

(findings section: HU 32, washout 9%)

Adrenal Gland Biopsy
Per radiology recommendation you send the patient to IR for FNA of the adrenal lesion. You get called the day of the procedure by radiology who tells you the patient coded and died during the procedure. You have to call the patient’s wife to explain what happened.

What did happen???

Pheochromocytoma/Paraganglioma
- Rule of 10s: 10% bilateral, 10% extra-adrenal, 10% malignant, 10% genetic >25% genetic
- Associated Genetic Syndromes:
  - Multiple Endocrine Neoplasia 2 (RET)
  - Familial Paraganglioma Syndrome (SDHA, SDHB, SDHC, SDHD, SDHAF2)
  - Von Hippel-Lindau Syndrome (VHL)
  - Neurofibromatosis Type 1 (NF1)
  - TMEM127
- Pheo Crisis/HTN Crisis/Catecholamine Storm
- NEVER EVER (hardly ever) BIOPSY AN ADRENAL MASS

Adrenocortical Carcinoma
- Typically present with pain and are very large
- Invasive
- Can secrete a lot of different hormones
  - Cortisol
  - Deoxycorticosterone (mineralocorticoid)
  - Androgens (Testosteron, Dehydroepiandrosterone (DHEA-S))
- Can have Cushings, huirsuitism, virulization
- Very poor prognosis
Algorithm for adrenal incidentalomas (one of many)


Frequency of Follow-up Imaging for Benign Lesion (< 10 HU)

- Never
- Once in 6-12 months (may reassure the physician and the patient)
- At 6, 12, and 24 months

Case

- 34 yow with worsening migraine HA and gets an MRI. She was noted to have an incidental 6 mm pituitary adenoma. What now?

Pituitary Incidentaloma

- 11% prevalence on autopsy data
- 10% prevalence on MRI (10-38%)

Pituitary Incidentaloma

- Pituitary adenoma (50-90%)
- Craniopharyngioma
- Rathke’s cleft cyst
- Other primary tumors in the pituitary
- Metastases
PITUITARY GLAND: Sagittal View

ANTERIOR PITUITARY

- Testing for Hypofunction
  - History and exam
  - Laboratory testing if suspicion - test end-organ function as basal levels of pituitary hormones are often normal in hypopituitarism

- Testing for Hyperfunction
  - History and exam
  - Laboratory testing for everyone – often dynamic testing with suppression tests

Pituitary Hypofunction

- GH (rarely tested)
  - IGF-1 level
  - GH stimulation test (insulin induced hypoglycemia)
- Gonadotrophs (FSH/LH)
  - Low Testosterone level without elevated LH
  - Amenorrhea in a young woman or lack of FSH elevation in a post-menopausal woman (estradiol not useful)
- TSH
  - Low free T4 level without elevated TSH
- ACTH
  - Cosyntropin (synthetic ACTH) stimulation test

Pituitary Hyperfunction

- Prolactin level (most common)
- IGF-1
Pituitary Hyperfunction

- Prolactin level (most common)
- IGF-1
- Screening for glucocorticoid excess??
  - Only if clinical suspicion
  - Dex suppression and not ACTH

Pituitary Incidentaloma

- Microadenoma < 1 cm
- Macroadenoma ≥ 1 cm
  - VF testing if near abutting or compressing the optic nerves or chiasm
- Follow-up imaging for non-secreting microincidentaloma
  - Repeat MRI yearly for 3 years and then less frequently

Case

29 yow comes to your office complaining of amenorrhea, anxiety, weight loss and tremors. You get a TSH which is < 0.01.

You then order a thyroid US which shows a 1.2 mm hyperechoic nodule and diffuse increased vascularity.

Five things Physicians and Patients Should Question

Don’t routinely order a thyroid ultrasound in patients with abnormal thyroid function tests if there is no palpable abnormality of the thyroid gland.

Thyroid ultrasound is used to identify and characterize thyroid nodules, and is not part of the routine evaluation of deceased thyroid function tests (serum or dynamic thyroid function tests). If the patient has a palpable lesion, a thyroid ultrasound should be performed. If the results of the ultrasound are normal, a thyroid nodule is not palpable, or the clinical evaluation rules out the nodule, then the thyroid ultrasound is not necessary. Imaging may be needed in older patients, in patients with a history of thyroid disease, a thyroid nodule, or when the ultrasound shows a lesion in the thyroid gland.
Case

62 yow complains of neck pain. Spine MRI has incidental finding of two thyroid nodules. It is recommended you get a thyroid US.

Thyroid Nodules and Cancer

- Prevalence of palpable thyroid nodules 4-7%
- Prevalence of nodules by US 19-67%
- Prevalence increases with age
- Approximately 5% of nodules are considered malignant on FNA
- Thyroid Cancer:
  - Differentiated Thyroid Cancer (90%)
    - Papillary
    - Follicular
  - Medullary Thyroid Cancer
  - Anaplastic Thyroid Cancer
  - Other
  - 97% 5 year survival

Case

62 yow complains of neck pain. Spine MRI has incidental finding of two thyroid nodules.
You order a thyroid ultrasound and get back a report saying:
Diffusely enlarged and heterogeneous thyroid with multiple masses bilaterally which may be consistent with a multinodular goiter. Although no one mass is more suspicious than the next, malignancy cannot be excluded in any given lesion. Clinical correlation with patient risk factors, physical exam, thyroid function tests, and nuclear scintigraphy is recommended.

Thyroid Nodule Evaluation

- Check TSH
- Only if suppressed get I-123 nuclear medicine scan to rule out toxic nodules which don't need FNA (the vast majority of nodules are cold)
- Biopsy with FNA all palpable nodules in euthyroid or hypothyroid patients
**Worrisome Things**

- Family history of thyroid cancer or history of radiation exposure
- On ultrasound:
  - Microcalcifications
  - Hypoechoic
  - Hypervascular (internal)
  - Irregular margins
  - Abnormal lymph nodes
  - Size
  - Taller than wide

**What to FNA?**

- Criteria for FNA of incidentally found nodules are in continual flux
- Many different sets of guidelines out there
  - American Thyroid Association/American Association of Clinical Endocrinologists
  - Society of Radiologists in Ultrasound (SRU)
  - Kim Criteria

**GUIDELINES**

- Kim criteria is any one of the following – Highest sensitivity (7% missed malignant lesions)
  - marked hypoechoogenicity, irregular or microlobulated margins, microcalcifications, or length greater than width.
- Society of Radiologists in Ultrasound (SRU)- least accurate
  - nodule 1 cm in diameter or larger with microcalcifications
  - 1.5 cm in diameter or larger that is solid or has coarse calcifications
  - 2 cm in diameter or larger that has mixed solid and cystic components
  - nodule that has undergone substantial growth or is associated with abnormal cervical lymph nodes.
- AACE- highest specificity (only FNA 26%)
  - Nodule 1 cm and hypoechoic
  - Any nodule and a hypoechoic nodule with at least one additional feature
- American Thyroid Association (ATA)
Basic Incidentaloma Principles

- Be judicious in your imaging to avoid finding incidentalomas.
- Don’t order a thyroid ultrasound for abnormal thyroid function tests.
- Nodules/adenomas are common in thyroid, pituitary and adrenal.
- Nodules in pituitary and adrenal need evaluation for hormonal secretion.
- NEVER biopsy an adrenal nodule.
- Hopefully, we will be doing fewer thyroid nodule biopsies in the future.

New Population Based US Data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of Cases per 1000 (95% CI)</th>
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<tbody>
<tr>
<td>Largest nodule (RUL, non-solitary), that is entirely cystic</td>
<td>0.12 (0.0-1.8)</td>
</tr>
<tr>
<td>Nodular goiter</td>
<td>0.64 (0.1-1.9)</td>
</tr>
<tr>
<td>Very small (&lt;1 cm)</td>
<td>2 (1-3)</td>
</tr>
<tr>
<td>Nodules &gt;1 cm with microcalcifications</td>
<td>1 (0.1-4.8)</td>
</tr>
<tr>
<td>Nodules &gt;1 cm without microcalcifications</td>
<td>1 (0.5-2.9)</td>
</tr>
<tr>
<td>Nodules &gt;1 cm with microcalcifications and a washout &gt;20%</td>
<td>0.6 (0.0-9.8)</td>
</tr>
</tbody>
</table>

References

- Endocrine society guidelines Pituitary incidentaloma
- Primary Aldosteronism
- American Thyroid Association Thyroid nodule Guideline (2009)
  - http://thyroidguidelines.net/revised/taskforce
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<thead>
<tr>
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<tbody>
<tr>
<td>• Pituitary</td>
<td>◦ 10%</td>
</tr>
<tr>
<td>• Adrenals</td>
<td>◦ 4-6%</td>
</tr>
<tr>
<td>• Thyroid</td>
<td>◦ &gt;50%</td>
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Avoid Imaging you don’t need