Adrenal and Thyroid Function and Disease

Medical Education Day
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January 29, 2004
Objectives

• Adrenal Gland
  - anatomy and function
  - disorders and testing
  - corticosteroid replacement

• Thyroid
  - anatomy
  - function and testing
  - disorders
Adrenal Glands

- paired organ
- 'supra-renal'
- pyramid shaped
- artery / vein from renal circulation
Normal Adrenal Glands
Cortex and Medulla

Slide 39 Adrenal gland
Adrenal Gland

CORTEX

c. zona glomerulosa

d. zona fasciculata

e. zona reticularis

f. MEDULLA
Adrenal Cortex - 3 products

• Mineralocorticoids
  - ALDOSTERONE
  - rx: Fludrocortisone (Florinef)

• Glucocorticoids
  - CORTISOL
  - rx: prednisone (Deltasone), more

• Androgens / Estrogens
  - TESTOSTERONE and ESTROGEN
  - rx: testosterone (Androderm)
  - rx: equine estrogen (Premarin)
Sterol Biosynthesis

Cholesterol → Pregnenolone → 17α → 17-hydroxypregnenolone → 17,20 → DHEA

Progesterone 17α → 17-hydroxyprogesterone → 17,20 → Androstenedione

Deoxycorticosterone → 21 → 11β → Corticosterone → 18 → Aldosterone

11-deoxycortisol → 21 → 17β → Testosterone → 17βR → Estradiol

Cortisol → 17,20 → Dihydrotestosterone → 5αR → Estradiol
Adrenal Medula - 1 product

- Catecholamines
  - ADRENALINE (epinephrine)
  - NOR-ADRENALINE (nor-epinephrine)
  - rx: epinephrine (Epi-pen)
  - rx: nor-epinephrine (Levophed, Ephedrine)
Medula and Cortex

Adrenal Medula

Adrenaline
Endocrine Diseases

TOO MUCH
or
TOO LITTLE
Endocrine Disease

• Diagnosis and Treatment
  - what does the hormone do?
  - how is the hormone regulated?
**Mineralocorticoids**

- **Aldosterone**
  - renin and angiotensin increases production
  - Increases Blood Pressure
  - Increases Salt (Na+) and Water Retention
  - Decreases potassium (kidney dumps K+)
Too Much Aldosterone
ACE-Inhibitors
- captopril
- enalipril
- ramipril
- lisinopril
- benazepril
- fosinopril
- quinapril

Angiotensin Receptor Blockers
- losartan
- irbesartan
- candesartan
- telmisartan
- valsartan

Aldosterone

Aldosterone Blocker
- spironolactone

Blood pressure rises
Salt retention
1. Blood pressure falls
2. Renin
3. Angiotensin
4. Aldosterone
Too Much Aldosterone

• Conn's Syndrome
  - tumor produces aldosterone

• Congenital Adrenal Hyperplasia
  - overactive production of aldosterone

• Atrophic Kidney
  - ischemic kidney makes angiotensin
Adrenal Tumor
Adrenal Tumor - Conn's
(they all look the same from a distance)
Treatments

- **Conn's Syndrome**
  - resect the tumor

- **Congenital Adrenal Hyperplasia**
  - medication (ACE-I, ARB, Spironolactone)

- **Atrophic Kidney**
  - medications or resect the kidney
Too Much Cortisol
Glucocorticoids

• Cortisol (stress hormone)
  - increases available energy
  - increases protein breakdown
  - increases glucose production
  - increases fatty acid availability
Cortisol Regulation

Circadian regulation
Stress:
Physical stress
Emotional stress
Hypoglycemia
Cold exposure
Pain

CRH
Anterior lobe of pituitary gland
ACTH
Cortisol
Adrenal cortex
Too Much Cortisol

• Cushing's Syndrome
  - thin skin, bruises, striae
  - moon facies, buffalo hump
  - cataracts
  - increases blood pressure
  - thins bones (osteoporosis)
  - immune dysfunction
  - increases glucose and obesity
  - muscle loss
  - mental status changes
Moon facies
Buffalo Hump
Central Obesity
Cushing's Syndrome

- Cushing's disease
  - pituitary tumor
- Adrenal Hyperplasia or Tumor
- Exogenous Glucocorticoids
  - cortisol
  - prednisone
  - dexamethasone
Cushing's Syndrome

• Screen
  - 24 hr urine production of cortisol

• Diagnosis
  - dexamethasone suppression test
Pituitary Tumor
Transphenoidal Surgery
Adrenal tumor
Too Little Cortisol and Aldosterone
Not Enough Cortisol

• Adrenal Insufficiency
  - low blood pressure
  - nausea
  - low sodium
  - sometimes very tanned
Hyperpigmentation

Addison's disease:
- Note the generalised skin pigmentation (in a Caucasian patient) but especially the deposition in the palmer skin creases, nails and gums.

- She was treated many years ago for pulmonary TB. What are the other causes of this condition?
Cortisol Regulation

- Circadian regulation
- Stress:
  - Physical stress
  - Emotional stress
  - Hypoglycemia
  - Cold exposure
  - Pain

- CRH
- ACTH
- Anterior lobe of pituitary gland
- Cortisol
- Adrenal cortex
Adrenal Insufficiency

• Addison's Disease
  - auto-immune destruction
• Other
  - hemorrhage into adrenal
  - infection
  - surgical resection
• Adrenal Suppression
  - among those receiving corticosteroids
Determine if Adrenal Functioning

- ACTH Stimulation Test
  - give ACTH --> see if adrenals respond
  - Time 00 min: baseline cortisol
  - Time 01 min: give ACTH 0.25 mg IV
  - Time 30 min: cortisol
  - Time 60 min: cortisol
  - > 500 umol /l if stimulated (like to see doubling, too)
Too much Adrenaline
Catecholamine Excess

- Pheochromocytoma
  - hypertension
  - palor
  - headaches
  - palpitations
  - anxiety
  - weight loss
- Increased Catecholamines in urine
  - metanephrines
- Treatment is Surgical
MIBG scan

| INSTITUTE: UNIVERSITY OF KANSAS MEDICAL CENTER KANS  |
| PROTOCOL: 131-I MIBG STATICS 10 HOURS POST INJ |

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Pheochromocytoma
Corticosteroids and Stress Coverage
Systemic Corticosteroids

- cortisone 1
- hydro-cortisone (solu-cortef) 1
- prednisone 4
- methyl-prednisolone (s-medrol) 5
- dexamethasone (IV or po) 30
Stress Dose to Prevent Adrenal Insufficiency

- normal day - cortisol 30 mg

- maximum stress - cortisol 300 mg (probably a lot less)

- Therefore, solu-cortef 100 mg IV q8h should be ample to cover 'stress'
Who needs 'stress' coverage?

- Patients with known adrenal failure

- Patients who in the last year...
  - got pharmacological dose of steroid
    - > 30 mg cortisol equivalents per day
  - > 10 - 14 days

- **probably very generous***
Thyroid
Thyroid Anatomy
Thyroid Gland - 2 products

- Thyroid hormone
  - increases metabolic rate

- Calcitonin
  - decreases calcium resorption from bone
  - increases renal loss of calcium & phosphate
Thyroid Hormone Regulation
Endocrine Diseases

TOO MUCH
or
TOO LITTLE
+Hyperthyroid

- nervousness
- increased sweating
- heat intolerance
- palpitation
- fatigue
- weight loss
- increased appetite
- hyperdefecation
- diarrhea

-Hypothyroid

- mental lethargy
- dry skin
- fatigue
- cold intolerance
- dyspnea
- weight gain
- constipation
- hoarseness
- edema
- menorrhagia
**+Hyperthyroid**

- tachycardia
- goiter
- tremor
- bruit over thyroid
- atrial fibrillation
- lid lag
- *proptosis
- *pretibial thickening

**-Hypothyroid**

- slow movement
- slow speech
- delayed relaxation phase of reflexes
- bradycardia
- coarse skin
- puffy face
- signs of heart failure
- loss of brows
Hypothyroid Facies
Sub-clinical Disease

• Most folks with thyroid dysfunction
  - non-specific symptoms
  - subtle symptoms
  - no symptoms (or signs)
Negative Feedback Loop

Hypothyroid
- Low T3 and T4
- High TSH

Hyperthyroid
- High T3 and T4
- Low TSH

Exception
- pituitary failure
Function does not equal size

- Enlarged Thyroid
  - underfunction
  - normal function
  - overfunction

- Small Thyroid
  - underfunction
  - normal
  - rarely overfunction (with hot nodule)
Function does not equal Disease

- Normal Function
  - does not exclude tumor
  - does not exclude nodule
  - does not exclude auto-immune thyroiditis
  - does not exclude Grave's disease
Size

- **Goitre** - increased size for any reason

- **Nodule** - discrete enlargement

- **Symptoms:**
  - Enlargement of the throat
  - Swallowing problems if large
  - Breathing problems if large
  - May or may not be painful
Goitre
Goitre
Goitre
Common Thyroid Diseases
Hashimoto's Thyroiditis

- 4.6% of adult population (common)
- Lymphocytic destruction of gland
- Painless
- Goitrous or Atrophic varieties
- Anti-thyroid antibodies are common
- High TSH, Low T4
- Treatment: Thyroid Supplement
Normal and Hashimoto’s
Subacute Thyroiditis

- Probably a viral induced immune attack
- Tender / painful thyroid
- Hyperthyroid > Hypothyroid > Euthyroid
- TSH fluctuates
- Self-limited
- Aspirin, NSAID, prednisone
Grave's Disease

- Auto-immune thyroid disease
- Antibodies activate the TSH receptor on the gland
- Hyperthyroidism
- Goitre
- Grave's ophthalmopathy
- Pre-tibial 'myxedema'
- Low TSH, high T4, anti-thyroid Ab
Grave's ophthalmopathy
Grave’s ophthalmopathy

- eyedrops
- steroids
  - prednisone
- surgery
- radiation

Computed tomogram of a patient showing enlargement of medial and lateral rectus muscles, which converge toward the orbital apex.

Pretibial 'myxedema'
Grave's Disease Treatment

- Medications
  - methimazole (Tapazole)
  - propyl-thiouricil (PTU)

- Radio-active Iodine

- Surgery

- (beta-blocker for any hyperthyroid)
Thyroid Nodules

- Localized Thyroid Disease
  - benign adenoma
  - malignant thyroid
  - Fine Needle Aspiration
  - Surgery if indeterminant or malignant
Thyroid Nodule
Hot and Cold Thyroid Nodules
Thyroid Cancer

- Papillary carcinoma (70-75%)
- Follicular carcinoma
- Anaplastic carcinoma
- Medullary thyroid carcinoma
- Lymphoma

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- Surgery
- High dose radioactive Iodine
- External Beam Radiation
- Chemotherapy
Other Thyroid Conditions

- Medication associated
  - amiodarone
  - iodine excess

- Post-partum thyroiditis

- Sick Euthyroid Syndrome

- Cretinism (congenital hypothyroidism)
Summary

• Thyroid and Adrenal conditions are common

• Knowing the hormone is knowing the disease

• Knowing the regulation is knowing how to test and treat.
Questions

• Note: all pictures from internet, not local patients.

• www.ucalgary.ca/~jpschaef