THYROID:
JUST THE BASICS

En.wikipedia.org 2000x838
Relevant relationships with commercial entities – none

Potential for conflicts of interest within this presentation – none

Steps taken to review and mitigate potential bias – N/A
LEARNING OBJECTIVES

This lecture is designed to meet the following end-of-week learning objectives:

1. Describe the embryology, and review the anatomy and histology of the pituitary, thyroid gland and adrenal glands
2. Describe the physiology and regulation of Hypothalamic-Pituitary-Target organ Axes (GH, prolactin, thyroid, adrenal, and briefly the ovaries and testes), including the production and action of the target organ hormones
3. Describe the principles of negative feedback in the Hypothalamic-Pituitary-Target organ axes physiology
4. Describe the function of thyroid hormone, TSH, cortisol, ACTH, aldosterone, renin, DHEAS, GH, IGF-1, prolactin, ADH
5. Describe the tests of function of the pituitary, thyroid and adrenal glands
LEARNING OBJECTIVES

6. Describe the presentation of pituitary/thyroid/adrenal disease: Hyperfunction, hypo function, mixed hyper- and hypo-function, masses

7. Describe the role of imaging in endocrine disorders (pituitary MRI, Thyroid ultrasound, radioactive iodine, thyroid scan, adrenal CT or MRI)

8. Interpret TSH and free T4 levels in determine the causes of hyper and hypothyroidism

9. Develop an approach to taking a thyroid disease history

10. Demonstrate a complete examination for hypothyroidism and hyperthyroidism
MODULE OBJECTIVES

By the end of this module, you should be able to:

1. Describe the anatomy and embryology of the thyroid gland, its function and how it is physiologically controlled

2. Describe the presentations of disorders of the thyroid gland, including:
   • Hyperfunction
   • Hypofunction
   • (Mass(es) -- week 29)

3. Describe how thyroid disorders are investigated
WHY IS THIS IMPORTANT?

1. Easy to diagnose
2. Common, so important to be aware
3. Potentially fatal
   - Thyroid cancer
   - Thyroid storm (severe hyperthyroidism)
   - Myxedema coma (severe hypothyroidism)
4. Effective therapy is available
THYROID ANATOMY

- Voicebox (larynx)
- Thyroid gland
- Parathyroid glands (behind the thyroid gland)
- Windpipe (trachea)
- Artery
- Vein
- Laryngeal nerve

https://www.urmc.rochester.edu/Encyclopedia
THYROID HISTOLOGY
THYROID HORMONE PHYSIOLOGY
THYROID HORMONE ACTIONS

• $\uparrow$ O2 consumption and heat production (i.e., increased basal metabolic rate)
• $\uparrow$ Cardiac output
• Potentiates: GH, catecholamines (epinephrine, norepinephrine), glucagon, cortisol
  – $\uparrow$ glucose absorption, gluconeogenesis, ketogenesis and proteolysis.
  – $\uparrow$ sensitivity to catecholamines by up-regulating their receptors.
• Required for normal growth in the fetus and child, including the central nervous system.
TSH HORMONE AXIS & FUNCTION

The Hypothalamic-Pituitary-Thyroid axis

Target tissues: Thermogenesis, protein synthesis
# PATTERNs OF HORMONE LEVELS

<table>
<thead>
<tr>
<th></th>
<th>Pituitary TSH</th>
<th>Target T4, T3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1° HYPER-</strong></td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>2° HYPER-</strong></td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td><strong>1° HYPO-</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>2°/3° HYPO-</strong></td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>
HOW DO THYROID PROBLEMS PRESENT?

- Hyperfunction (thyrotoxicosis)
- Hypofunction (hypothyroidism)
- Mass effect/Malignancy
- Associated problems
COMMON CAUSES OF THYROTOXICOSIS

Hyperfunction (Hyperthyroidism)
- Graves’ disease
- Multinodular goitre
- Toxic adenoma
- Pregnancy-related (b-HCG)

Leak or excess ingestion
- Subacute thyroiditis
- Too much L-Thyroxine or Complementary medication with T4 or T3
HOW DOES HYPERFUNCTION OF THE THYROID PRESENT?

Hypermetabolism
- Heat intolerance
- Weight loss despite normal appetite

Other symptoms
- Reduced menses
- Increased bowel movements
- Skin soft, moist
- Hair is silky

Overactivity of adrenergic system
- Palpitations,
- Tremulousness
- Anxiety

Associated problems In setting of Graves’ disease
- Graves’ orbitopathy
- Graves’ dermopathy

In setting of thyroiditis:
- May have tender thyroid
PHYSICAL EXAMINATION

- General appearance:
  - Anxious, warm hands, silky skin, glossy hair
- Vital signs:
  - Increased HR, systolic hypertension
- Eyes:
  - Stare, lid lag (may have Graves’ orbitopathy with proptosis)
- Thyroid:
  - Enlarged? Nodular? Bruit? Tender?
- Neurologic:
  - Tremor, proximal muscle weakness, increased reflexes
- Other:
  - Congestive heart failure
### PATTERNS OF HORMONE LEVELS

<table>
<thead>
<tr>
<th></th>
<th>Pituitary TSH</th>
<th>Target T4, T3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1° HYPER-</strong></td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>2° HYPER-</strong></td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td><strong>1° HYPO-</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>2°/3° HYPO-</strong></td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>
CAUSES OF PRIMARY THYROTOXICOSIS

Graves’ disease
- Autoimmune disease
  Thyroid-stimulating Immunoglobulin” (TSI) behaves just like TSH

Toxic adenoma
- Benign tumor of gland
- Makes hormone in unregulated way, independent of TSH

Multinodular goitre
- Several benign nodules make excess hormone

Subacute thyroiditis:
- 2 types (painful or painless)
- Associated viral illness or autoimmune process
- Get injury to thyroid
  - Hormone leaks out of gland (thyrotoxicosis)
  - Later hypothyroid phase
WHY IS MY PATIENT THYROTOXIC?

1. Confirmed ↓ TSH, ↑T4 + T3
2. Does the physical exam give clues?
3. Check TSI
4. RadioActive Iodine (RAI) uptake
   Give iodine, and see if the gland incorporates it:
   - ↑uptake (high %) (ie, incorporated) → gland is overactive (hyperthyroid)
   - ↓uptake (low %) (ie, not incorporated) →
     Gland leaked thyroid hormone (thyroiditis) or
     Patient is taking thyroid hormone or iodine
CAUSE OF THYROTOXICOSIS BASED ON RADIOACTIVE IODINE UPTAKE

HIGH uptake
1. Graves’ disease
2. Multinodular goiter
3. Toxic adenoma
Treat with
1. β-blocker
2. Thionamide OR radiation OR surgery

LOW uptake
1. Subacute thyroiditis
2. Ingesting thyroid hormone

Treat with β-blocker only
HOW DO THYROID PROBLEMS PRESENT?

• Hyperfunction
• Hypofunction
• Mass effect
• Malignancy
• Associated problems
HYPOTHYROIDISM

- Primary (THYROID CAUSE)
  - Congenital (absence of gland, enzyme defects)
  - Hashimoto’s (autoimmune destruction)
  - Subacute thyroiditis (after thyrotoxic phase)
  - Iatrogenic: drugs (thionamide, iodine, amiodarone, lithium), radioactive iodine, surgery

- Secondary/tertiary (PITUITARY OR HYPOTHALAMIC CAUSE)

- Peripheral resistance
HOW DOES HYPOFUNCTION OF THE THYROID PRESENT?

• Everything slows down
  • Fatigue, difficulty concentrating, dementia
  • Weight gain despite reduced food intake
  • Bradycardia
  • Constipation
  • Dry skin and hair
  • Amenorrhea or menorrhagia

• Swelling
  • Around the eyes “myxedema”
  • Around the heart and lungs
PHYSICAL EXAM IN THE HYPOTHYROID PATIENT

• Slowness, depression, dementia
• Periorbital edema
• Hoarse voice
• Dry skin and hair
• ↓ HR, ↑ diastolic BP
• Enlarged thyroid or neck scar?
• Delayed relaxation of reflexes
PATTERNS OF HORMONE LEVELS

Pituitary TSH Target T4, T3

1° HYPER- ↓ ↑

2° HYPER- ↑ ↑

1° HYPO- ↑ ↓

2°/3° HYPO- ↓ ↓

1° HYPER-

2° HYPER-

1° HYPO-

2°/3° HYPO-
WHAT IS THE sTSH?

- sTSH 20 (normal 0.5-5.0)

- Choosing wisely: when you think someone is hypothyroid, you should screen with a sTSH level, not free T4 level (unless concerned about pituitary disease)
WHY HYPOTHYROID?

• Primary (THYROID CAUSE)
  – Congenital (absence of gland, enzyme defects)
  – Hashimoto’s (autoimmune destruction)
    • Measure anti-thyroid antibodies
  – Subacute thyroiditis (after thyrotoxic phase)
  – Iatrogenic: drugs (thionamide, iodine, amiodarone, lithium), radioactive iodine, surgery
• Secondary/tertiary (PITUITARY OR HYPOTHALAMIC CAUSE)
• Peripheral resistance
MODULE OBJECTIVES

By the end of this module, you should be able to:

1. Describe the anatomy and embryology of the thyroid gland, its function and how it is physiologically controlled

2. Describe the presentations of disorders of the thyroid gland, including:
   • Hyperfunction
   • Hypofunction
   • (Mass(es)-- week 29)

3. Describe how thyroid disorders are investigated
Extra reading material...
HOW DO THYROID PROBLEMS PRESENT?

• Hyperfunction
• Hypofunction
• Mass effect
• Malignancy
• Associated problems
WHAT MIGHT SHE COMPLAIN OF?
WHAT MIGHT SHE COMPLAIN OF?

She might complain of:

1. Dysphagia (difficulty swallowing)
2. Dysphonia (hoarseness)
3. Stridor (noisy inhalation)
4. Noticing the mass
TWO TYPES OF NODULES:

• **HOT** nodule → Do **NOT** biopsy (FNA- Fine needle aspirate)
  – Overproduces thyroid hormone
  – Shows up on radioisotope scan as “hot” (dark) spot when radioactive iodine is incorporated
  – TSH is suppressed so the rest of gland looks cold (blank) on scan
  – Risk of cancer is “zero”, so don’t FNA it

• Most are **COLD** nodules → **BIOPSY**!
  – Non-functional → Does not take up radioisotope on scan, therefore looks blank (like background) on scan
  – TSH will be usually be normal (unless there is an additional thyroid condition in the rest of the thyroid, such as co-existing Graves’ disease)
  – 5-15% risk of malignancy in a cold nodule, so needs FNA
<table>
<thead>
<tr>
<th>Structure (nodule(s))</th>
<th>Function</th>
<th>Specialized tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab tests</td>
<td>Cytology: FNA (Fine needle aspirate biopsy)</td>
<td>sTSH $\rightarrow$ screen for hypothyroidism or thyrotoxicosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free T4 $\rightarrow$ confirm hypothyroidism or thyrotoxicosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free T3 $\rightarrow$ confirm thyrotoxicosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSI (Thyroid stimulating immunoglobulin) $\rightarrow$ Graves’ disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anti-thyroid antibodies $\rightarrow$ Hashimoto’s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thyroglobulin $\rightarrow$ thyroid cancer recurrence</td>
</tr>
<tr>
<td>Nuclear testing</td>
<td>Scan (picture) For nodule(s) with ↓TSH</td>
<td>RAI (%) for Thyrotoxicosis</td>
</tr>
<tr>
<td>Imaging</td>
<td>Ultrasound (rarely CT, PET scan)</td>
<td></td>
</tr>
</tbody>
</table>