Thyroid Embryology

- **Day 24**
- Endodermal thickening on floor of pharynx (Foramen cecum in adults)
- **Thyroglossal Duct**: growth into neck anterior to hyoid/thyroid cartilage
  - Disappears by Day 50
- **Thyroglossal Duct Cyst**: persistence in adults
- **Pyramidal Lobe**: persistence of migration
  - 50% of adults
Thyroid Anatomy

- Two lobes, anterior to larynx / trachea

Arterial Supply:
- Superior thyroid a.: 1st branch of ECA
- Inferior thyroid a.: branch of thyrocervical trunk

Venous Drainage:
- Superior, Middle, Inferior thyroid veins

Muscle coverage: platysma, SCM, straps
Thyroid Physiology

- **Follicular Cells**
  - Capture Iodine from circulation
    - Rate-limiting step
  - Concentrate iodine to 30x
  - Oxidized by *Thyroid Peroxidase (TPO)*
    - Membrane-bound enzyme
    - Called organification
  - Makes *Thyroglobulin* & releases into follicle
Thyroid Physiology

- Follicle
  - Extracellular storage for follicular cells
  - Thyroglobulin meets Oxidized Iodine
    - MonolodoTyrosine (MIT)
    - DilodoTyrosine (DIT)
  - Coupling of MIT/DIT form T3 & T4
  - T3, T4: storage forms of thyroid hormone
Thyroid Physiology

- TSH stimulates release of active hormone
- T3/T4 taken back by Follicular Cells
  - Endocytosis
  - Hydrolyzed & released, leaving thyroglobulin
- 80% of circulating hormone = T4
- T3 also made by peripheral conversion
  - T4 → T3
  - Most active form
Thyroid Physiology

- **TSH (ant pituitary) ➔ follicular cells**
  - Stimulated T3/T4 release
  - Increase thyroglobulin synthesis
  - Increase iodine transport
- **TRH (hypothalamus) ➔ TSH**
  - Thyrotropin-releasing hormone
  - Increases TSH release
- **T3/T4 (Thyroid) ➔ Inhibits TSH, TRH**
Thyroid Physiology

- **Parafollicular Cells (C cells)**
  - From neural crest cells
  - High calcium → Calcitonin
    - Inhibits osteoclasts
Thyroid Nodule

- 4% of population w/ palpable nodules
- 50% solitary, 50% multiple
- H&P: local compressive sx, duration, toxicity
- Family hx: MEN, childhood hx radiation
- Labs: TSH, T4, T3
- Dx: U/S (solid vs cystic), FNA
- Tx: Benign → thyroid hormone / TSH suppression
- Intermediate/Malignant FNA → Lobectomy
- Final Path: Follicular, Medullary, Anaplastic, Most Papillary → Completion Total Thyroidectomy
Thyroid Nodule

- **Dx:** FNA $\rightarrow$ single most important study
  - Only 3% w/ benign path have CA (false neg)
  - 85% w/ malignant path have CA (true pos)
  - Follicular adenoma vs CA only dx by full path: capsular / vascular invasion (not on cytology) $\rightarrow$ must resect for dx
- **Dx:** U/S $\rightarrow$ cystic vs solid, exact size
  - If cystic $\rightarrow$ U/S FNA, if disappears, then done
  - If residual mass, FNA mass, consider OR
  - If solid $\rightarrow$ FNA $\rightarrow$ benign, indeterminate, malignant
Hyperthyroidism-Grave’s’s

- Grave’s Disease: most common
- Diffuse goiter, exophthalmos, tachycardia, tremor, heat intolerance, wt loss, young women
- Immunoglobulin G (TSAb): against TSH receptors on follicular cells
- Dx: diffusely enlarged gland, Ab positive, other Sx
- Tx:
  - Medical (1/3)
    - Iodide (Lugol’s soln) blocks thyroid hormone release
    - Beta blockers (Propranalol) decr T4-T3 conversion
    - Thionamides (PTU/Methimazole) blocks hormone synthesis
  - Radioablation: Iodine-131 destroys follicular cells
  - Surgical: Thyroidectomy (esp if pregnant)
Hyperthyroidism - Toxic Adenoma

- Solitary hyperactive tumor, CA rare
- Not autoimmune w/ other sx like Grave’s
- High T3, T4, Low TSH
- Dx: NI Thyroid w/ palpable “hot” nodule
- Tx: Not as good w/ medical tx/radiation
  - Lobectomy
Hyperthyroidism-Toxic Multinodular Goiter

- Many hyperactive nodules → goiter
  - +/- compressive sx
- “hot” on thyroid scan
- Tx: Not as good w/ medical/radioablation
  - Total vs Subtotal Thyroidectomy
Thyroid Carcinoma

- More common in women, middle-aged
- **Papillary**: most common (70-80%)
  - Grow slowly, good prognosis, mets to LN
  - If good factors (<45yrs, <1cm) → lobectomy
  - Otherwise → total thyroidectomy
  - Postop radioablation if residual/met, >1cm
  - Lifelong thyroid replacement
  - Mets to lungs, bones
  - Poor prognosis: men, >50yrs, >4cm, invasion
Thyroid Carcinoma

- **Follicular**: 10-20%
  - May look like adenomas on FNA, only difference by invasion on path
  - Grow slowly, good prognosis if small
  - Poor prognosis: >45yrs, invasion

- Total thyroidectomy
- Mets to lung, bone
- +/- Radioablation after removed
Thyroid Carcinoma

- **Medullary**: associate w/ MEN
  - Worse prognosis, elevated calcitonin
  - Total thyroidectomy w/ LN dissection
- **Anaplastic**: very aggressive, palliation
- **Lymphoma**: mass in neck & other sites
  - Differentiate from Hashimoto’s w/ bx
Thyroidectomy

- Preserve **parathyroid glands**
  - Can reimplant (autograft) into muscle
  - Transient hypoparathyroidism (low Ca)
- Preserve **recurrent laryngeal nerve**
  - Paralysis of vocal cord on one side → hoarse
  - If both injured, then needs tracheostomy
- Preserve **superior laryngeal nerve**
  - Loss of voice quality & high-pitched range
Parathyroid Gland

- 90% of adults have 4 glands
- Arterial Supply: Inferior Thyroid Artery
- Venous drainage: IJ, SC, Innominate
- Usually just beneath the thyroid capsule near the recurrent laryngeal nerve
- Secretes Parathyroid Hormone (PTH)
  - Increases serum Calcium
  - Calcitonin by Parafollicular Thyroid Cells decreases serum Calcium
Hyperparathyroidism

- **Primary:**
  - Hyperactive gland(s) → Excess PTH
  - Adenoma (85%), Hyperplasia (15%)

- **Secondary:**
  - Renal failure w/ loss of serum calcium → PTH
  - Excess PTH by all glands

- **Tertiary:**
  - Chronically stimulated hyperplastic glands of renal failure pt starts to produce PTH on their own even after renal transplant
Hyperparathyroidism

- “stones, bones, groans, moans, & psych overtones”—from too much calcium
  - Kidney stones, bone resorption, diffuse pain / fatigue, abd pain from ulcers / pancreatitis, depression / psychosis
- Usually not symptomatic, from primary dz in oupts or malignancy in inpts
- Dx: PTH, Ca, urine Ca, Vit D
Hyperparathyroidism

- **Tx: Medical for Elevated Calcium**
  - Normal Saline, Diurese w/ Lasix, bisphosphonates

- **Tx: Surgical**
  - Single-gland resection for adenoma
  - Subtotal (3 ½ ) resection for hyperplasia
    - Also for secondary & tertiary
    - Reimplant in muscle
  - **Sestamibi scan** (localizes “hot” parathyroid)
  - Intraop PTH drop after resection
Adrenal Gland

- Above the kidney (suprarenal)
- 3 Arteries: superior, middle, inferior
- 1 Vein: IVC on Right, Renal Vein on Left
- Regions: Cortex (3 zones) & Medulla
  - Zona Glomerulosa: aldosterone $\rightarrow$ salt
  - Zona Fasciculata: cortisol $\rightarrow$ sugar
  - Zona Reticularis: DHEA $\rightarrow$ sex steroid
  - Medulla: catecholamines (epinephrine)
Primary Hyperaldosteronism - Conn’s syndrome

- Zona glomerulosa (aldosterone) → salt
- Triad: HTN, low K, high aldosterone/low renin
- If secondary, then volume depletion → renin → aldosterone (CHF)
- Solitary adenoma vs hyperplasia vs CA
  - Adenoma is unilateral mass on CT
  - Venous sampling for aldosterone in adrenal veins
- Tx: fix low K first, Lap adrenalectomy for adenoma → 70% BP nl
- Tx: If hyperplasia, medical tx only w/ spironolactone
Cushing's Syndrome/Disease

- Zona Fasciculata (Cortisol) → sugar
- Syndrome is the effect (usu medication)
- Disease is the cause (pituitary adenoma)
- ACTH from pituitary stimulates adrenal
- Classic: female, central obesity, HTN, DM, moon face, hirsutism
- Dx: Cortisol, ACTH, dexamethasone suppression test, CT/MRI
- Tx: Steroid inhibitors (mitotane), radiation
- Pituitary Adenoma: transsphenoidal resection
- Adrenal Adenoma: lap adrenalectomy & prednisone
- Adrenal Hyperplasia: Bilateral adrenalectomy, lifelong steroids
Adrenal Cortical Carcinoma

- Rare, usually left-sided, female
- Associated with hypersecretion (Cushing’s)
- Variable production of hormones
- Large, abdominal mass
- 50% metastatic at presentation
- Dx: CT: irregular, central necrosis
- Tx: Surgical excision w/ LN, Chemo (Mitotane) if mets/unresectable
- Median survival = 15 months
Incidental Adrenal Mass

- Risk of CA increases if >4cm
- Dx: hormone activity
- Must rule out pheochromocytoma
- FNA (if not pheo) to eval for mets
- Tx: all functional tumor, >6cm $\rightarrow$ excision
- Tx: If <3-4cm, nonfxnal $\rightarrow$ close f/u
Pheochromocytoma

- **Adrenal Medulla** (usually), also periaortic catecholamines
- **Pres:** HTN (episodic), palpitations, HA, sweating, anxiety, wt loss, constipation
- Usually sporadic, also a/w MEN, others
- **Dx:** serum & urine catecholamine levels, metabolites (metanephrine, normetanephrine, VMA)
- Localize: CT vs MIBG scan
- **Tx:** surgical excision
- Preop w/ alpha blocker & hydration, then beta blocker
- Postop crisis (**Addisonian crisis**): low BP, N/V, high K tx w/ IV steroids