Bio217: Pathophysiology Class Notes
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Unit V: Endocrine System Disorders

Chap. 17: Mechanisms of Hormonal Regulation
Chap. 18: Alterations of Hormonal Regulation

The Endocrine System

• Components
  – Glands located around the body that secrete chemical messengers (hormones)

• Functions
  – Works with CNS to regulate and integrate metabolism and maintain homeostasis

Hypothalamus (“heart of the endocrine system”)

• Center for integrating endocrine and ANS
• Regulates endocrine glands via neural and hormonal pathways

  • Posterior Pituitary (neural pathways)
    • ADH (antidiuretic hormone)
    • Oxytocin
  • Anterior Pituitary (hormonal control)
    • ACTH (adrenocorticotropic horm.)
    • TSH (thyroid stim. hormone)
    • LH (luteinizing hormone)
    • FSH (follicle stim. hormone)
    • PRL (prolactin)
    • GH (growth horm.)

Negative Feedback - regulates the endocrine system by inhibiting overproduction of hormones

Lipid-Soluble Hormones
Endocrine disorders

- May be caused by
  - Hypersecretion or hyposecretion of hormones
  - Hyporesponsiveness of hormone receptors
  - Gland inflammation
  - Tumors of glands

Adrenal glands

- Embedded in fat superior to each kidney

  **Adrenal cortex:**
  1. **Aldosterone** (mineralcorticoid)
     - regulates Na+ reabsorption & excretion of K+
  2. **Cortisol** (glucocorticoid)
     - stimulates gluconeogenesis
     - protein breakdown and fatty acid mobilization
     - suppression of immune system
     - increased stress response
     - maintains BP and CV fcn.
  3. **Adrenal androgens & estrogens** (steroid hormones)

- **Aldosterone**
  - Epinephrine & Norepinephrine (catecholamines)
    - produce VC
    - SNS response ("fight or flight")
Catecholamines

Thyroid and Parathyroid Glands

- **Thyroid gland**
  - Located in anterior neck; two lobes lie on either side of the trachea
  - Secrete iodine-containing hormones
    - T3 and T4 — nec. for growth & dev.; increase metabolism
    - Calcitonin — regulates blood Ca++ levels

- **Parathyroid glands**
  - 4 glands located on posterior aspect of thyroid
  - Secrete PTH
    - Regulates blood Ca++ levels

Thyroid and Parathyroid Glands

Endocrine Pancreas

- The pancreas is both an endocrine and exocrine gland
- Contains pancreatic islets (of Langerhans)
  - Secretion of glucagon and insulin
  - Cells
    - Alpha — glucagon ( nec. when fasting $\rightarrow$ increased BG)
    - Beta — insulin (released after a meal $\rightarrow$ decreased BG, stim. protein syn. and fatty acid uptake & storage)

Endocrine Pancreas

Concept Check

- 1. Organs that respond to a particular hormone are called:
  - A. target organs
  - B. integrated organs
  - C. responder organs
  - D. hormone attach organs

- 2. The hypothalamus controls the anterior pituitary by:
  - A. Nerve impulses
  - B. PG
  - C. Regulating hormones
  - D. None of the above
3. In a negative feedback mechanism controlling thyroid hormone secretion, which is the nonregulatory hormone?

- A. TRH
- B. TSH
- C. thyroxine
- D. All of the above are regulatory for thyroid hormone secretion

Matching:

4. ACTH
- a. Mammary glands
5. TSH
- b. Adrenal cortex
6. TRF
- c. Thyroid gland
7. prolactin
- d. Ant. pit.

Matching:

8. Epi
- a. Influence inflam. response
9. Glucocorticoids
- b. Causes fight or flight response
10. Mineralcorticoids
- c. Controls Na+, H+, K+
11. Gonadocorticoids
- d. Act as minor sex hormones

Alterations of Hormonal Regulation
Chapter 18

Elevated or Depressed Hormone Levels

- Failure of feedback systems
- Dysfunction of an endocrine gland
- Secretory cells are unable to produce, obtain, or convert hormone precursors
- The endocrine gland synthesizes or releases excessive amounts of hormone

- abnormal hormone levels

Endocrine Disorders

- Pituitary disorder of water metabolism (diabetes insipidus)
- 3 Thyroid gland disorders (goiter, hyperthyroidism, hypothyroidism)
- Pancreatic disorder (diabetes mellitus: type 1 and type 2)
- 2 Adrenal disorders (Addisons’s and Cushing’s syndrome)
Elevated or Depressed Hormone Levels

- Increased hormone degradation or inactivation
- Ectopic hormone release

Diseases of the Posterior Pituitary

- **Diabetes insipidus**
  - Deficiency of ADH (aka vasopressin)
  - Polyuria (4-16 L/day) and polydipsia
  - Partial or total inability to concentrate urine
  - **Causes:** drugs or injury to posterior pituitary; lesions in hypothalamus, infundibulum or post. pit.
  - Normally ADH is syn. in hypothalamus and stored in post. pit. ADH is released when plasma osmolality increases \(\rightarrow\) increased permeability to dct and cd in kidney \(\rightarrow\) increased reabsorption of water.
  - **When ADH is missing:** results in increased excretion of water \(\rightarrow\) large amt. of dilute urine

Diabetes Insipidus

- **Pathophysiology:**
  - Patients not able to concentrate urine
  - Deficiency of ADH \(\rightarrow\) increased vol. of dilute urine
  - \(\rightarrow\) dehydration if fluids are not replaced
- **Treatment:** replacement of ADH

Alterations of Thyroid Function

- **Goiter** = enlargement of thyroid gland
  - not due to inflammation or neoplasm
  - Classified as:
    - nontoxic (increased demand for TH during adolescence, pregnancy or menopause) and
    - toxic (due to long term nontoxic, occurs in elderly)
  - Please pass the iodine
    - Endemic goiter due to insufficient dietary iodine \(\rightarrow\) insufficient production of TH
    - Too much of a good thing
      - Sporadic goiter due to ingestion of goitrogenic foods* (inhibit thyroxine) or drugs

Goiter

- **Pathophysiology**
  - Decreased iodine plus impaired synthesis of TH \(\rightarrow\) responsiveness of thyroid to TSH
  - Increased mass and cell activity may overcome mild thyroid impairment (Patient has goiter but normal fcn.)
  - If severe impairment \(\rightarrow\) goiter and hypothyroidism

Alterations of Thyroid Function

- Hyperthyroidism
**Hyperthyroidism or thyrotoxicosis (Graves Disease)**

- **Graves’ Disease**
  - *How grave is Graves’ disease?*
  - Graves’ disease is the most common type
  - Autoimmune, 30-60 years old, family history of thyroid abnormalities
  - Thyroid-stimulating antibodies bind to TSH receptors
  - Thyroid storm (thyrotoxic crisis)
    - Overproduction of T3 and T4 → increased SNS activity
      - (tachycardia, vascular collapse, hypotension, coma, death)

- **Graves’ disease**
  - *Signs & Symptoms*
    - Enlarged thyroid
    - Exophthalmos (bulging eyes)
    - Nervousness, weight loss w/ increased appetite
  - *Treatment*
    - Antithyroid drugs (propylthiouracil, methimazole)
    - 131 I (radioactive iodine therapy)
    - Surgery

- **Alterations of Thyroid Function**
  - *Hypothyroidism*
    - Thyroid deficiency (decreased T3 and T4) → metabolic processes slow (may be problem with thyroid, pituitary, or hypothalamus)
    - Primary hypothyroidism – due to disorder of thyroid
    - Secondary hypothyroidism – due to failure to stimulate thyroid
    - Causes: thyroidectomy, radiation, not enough TSH (from pituitary) or TRH (from hypothalamus)
    - Symptoms: fatigue, wt. gain, facial puffiness, dry skin, bleeding tendencies

- **Pathophysiology**
  - Loss of thyroid tissue → decreased TH, increased TSH and goiter (primary)
  - Decreased TSH from pituitary most commonly due to tumors (secondary)
  - Myxedema - composition of dermis is changed (puffiness)
  - Myxedema coma - depressed respiratory system, decreased cardiac output, bradycardia & hypotension
  - Treatment: TH replacement gradually (levothyroxine)

- **Hypothyroidism**

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Diabetes Mellitus

- Body does not produce or use insulin properly
- Results in hyperglycemia
- Type 1 (IDDM = insulin-dependent)
- Type 2 (NIDDM = non-insulin-dependent)

Type 1 diabetes

- **Pathophysiology (Type 1)**
  - Islet cell (beta cell) destruction → no insulin production
  - Autoimmune (genetic & environmental)
  - Nonautoimmune (idiopathic)

- **Symptoms**
  - Lack of insulin → hyperglycemia occurs w/ 89-90% destruction of beta cells; excess glucagon by alpha cells
  - Glucosuria, polyuria, polydipsia
  - Ketoacidosis due to fat and protein metabolism → DKA coma

- **Treatment**: Insulin, meal planning and exercise, Hb A1C

Type 2 diabetes mellitus

- **Pathophysiology**
  - Idopathic, genetic and environmental factors
  - Insulin resistance in target tissues
  - Overproduction of glucose via gluconeogenesis
  - Obesity

- **Symptoms**
  - Recurring skin infections
  - Visual changes (blurred vision, retinopathy)
  - Paresthesias
  - Fatigue (poor eating)

- **Treatment**
  - Personalized meal plan & exercise

Acute Complications of Diabetes Mellitus

- Hypoglycemia (insulin shock- decr. BG levels)
- Diabetic ketoacidosis DKA → dec. insulin levels → elevated BG levels → fat mobilized
- Somogyi effect — hypoglycemia followed by hyperglycemia (rebound)
- Dawn phenomenon — early morning elevated BG

Diabetic Ketoacidosis

Chronic Complications of Diabetes Mellitus

- Hyperglycemia
- Microvascular disease
  - Retinopathy
  - Diabetic nephropathy
- Macrovascular disease
  - Coronary artery disease
  - Stroke
  - Peripheral arterial disease
- Diabetic neuropathies
- Infection
Alterations of Adrenal Function

- Disorders of the adrenal cortex
  - Cushing disease
    - Excessive anterior pituitary secretion of ACTH
  - Cushing syndrome
    - Cluster of abnormalities due to excessive levels of cortisol (glucocorticoid)
    - Wt. gain, muscle weakness, fatigue, buffalo hump, thin extremities, bruise easily
- Treatment:
  - Radiation, drugs, surgery depending on cause

Addison’s disease

- (adrenal insufficiency or hypofunction)
- Decreased mineralcorticoid, glucocorticoid, and androgen secretion
- Cause — usually from autoimmune process
  - Idiopathic, TB, removal of adrenals, neoplasms, infections
- Adrenal crisis
  - Inadequate or nonresponsive hormone therapy
  - Extreme stress
  - hypoglycemia, hypotension → coma → death

Cushing Disease

A. Before onset of Cushing syndrome
B. 4 months later

Concept Check

1. Which clinical symptoms are shared by DM and diabetes insipidus?
   - A. Elevated blood and urine glucose levels
   - B. Inability to produce ADH
   - C. Inability to produce insulin
   - D. Polyuria
2. Graves disease is:
   - A. Hyperthyroidism
   - B. Associated with autoimmunity
   - C. Characterized by ophthalmopathy
   - D. All of the above
3. A 24-year old female with a history of “juvenile onset” diabetes is found in a stupor. She has cold, clammy skin, what is most likely the cause of her condition?
   - A. Hyperglycemia
   - B. Insulin shock
   - C. Renal failure
   - D. Retinopathy
4. Common signs and symptoms of DM include all of the following except:
   - A. Hyperglycemia
   - B. Blurred vision
   - C. Increased muscle anabolism
   - D. Polyuria

Matching:

5. Cushing disease
6. Goiter
7. Addison disease