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

Mechanisms of Hormonal Regulation

Chapter 17

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)
  • GH (growth horm.)

Lipid-Soluble Hormones

Negative Feedback – regulates the endocrine system by inhibiting overproduction of 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 (catecholemines)
  - 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 → increased BG)
    - Beta – insulin (released after a meal → decreased BG, stim. protein syn. and fatty acid uptake & storage)

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
- 5. TSH
- 6. TRF
- 7. prolactin

Matching:

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

Matching:

- 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

- \( \Rightarrow \) 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 (Addison'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 → increased permeability to dct and cd in kidney → increased reabsorption of water.
  - **When ADH is missing:** results in increased excretion of water → large amt. of dilute urine

Diabetes Insipidus

- **Pathophysiology:**
  - Patients not able to concentrate urine
  - Deficiency of ADH → increased vol. of dilute urine
  - → 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 → 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 → responsiveness of thyroid to TSH
  - Increased mass and cell activity may overcome mild thyroid impairment (Patient has goiter but normal fcn.)
  - If severe impairment → goiter and hypothyroidism

Alterations of Thyroid Function

- **Hyperthyroidism**

  ![Diagram of Hyperthyroidism]
Hyperthyroidism or thyrotoxicosis (Graves Disease)

Graves’ Disease
• How grave is Graves’ disease?
• Graves’ disease is 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
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 with 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**
  - Idiopathic, 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
  • \( \rightarrow \) hypoglycemia, hypotension \( \rightarrow \) coma \( \rightarrow \) 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 A. Excess cortisol
• ___ 6. Goiter B. Enlarged thyroid
• ___ 7. Addison disease C. Adrenal hypofunction