Surgery 432 Team

6 Adrenal Gland

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COLOR GUIDE: • Females' Notes • Males' Notes • Important • Additional

Outlines

1. Anatomy and Physiology of the Adrenal Gland.
2. Cushing's Syndrome.
3. Conn's Syndrome.
4. Addison's Disease.
5. Adrenalectomy.
6. Pheochromocytoma.
7. Adrenal Incidentaloma.

Anatomy and Physiology of the Adrenal Gland

Anatomy [1]: The adrenal glands are located in the retroperitoneum superior to the kidney and lateral to the vena cava (right) and aorta (left). Three arteries supply each adrenal: **superior adrenal artery (arise from the inferior phrenic artery), middle adrenal artery (branch of the aorta), and inferior adrenal artery (branch of the renal artery).**

The right adrenal vein drains into the vena cava. The left adrenal vein drains into the left renal vein.

Physiology [1]: The adrenal gland is historically composed of four layers:

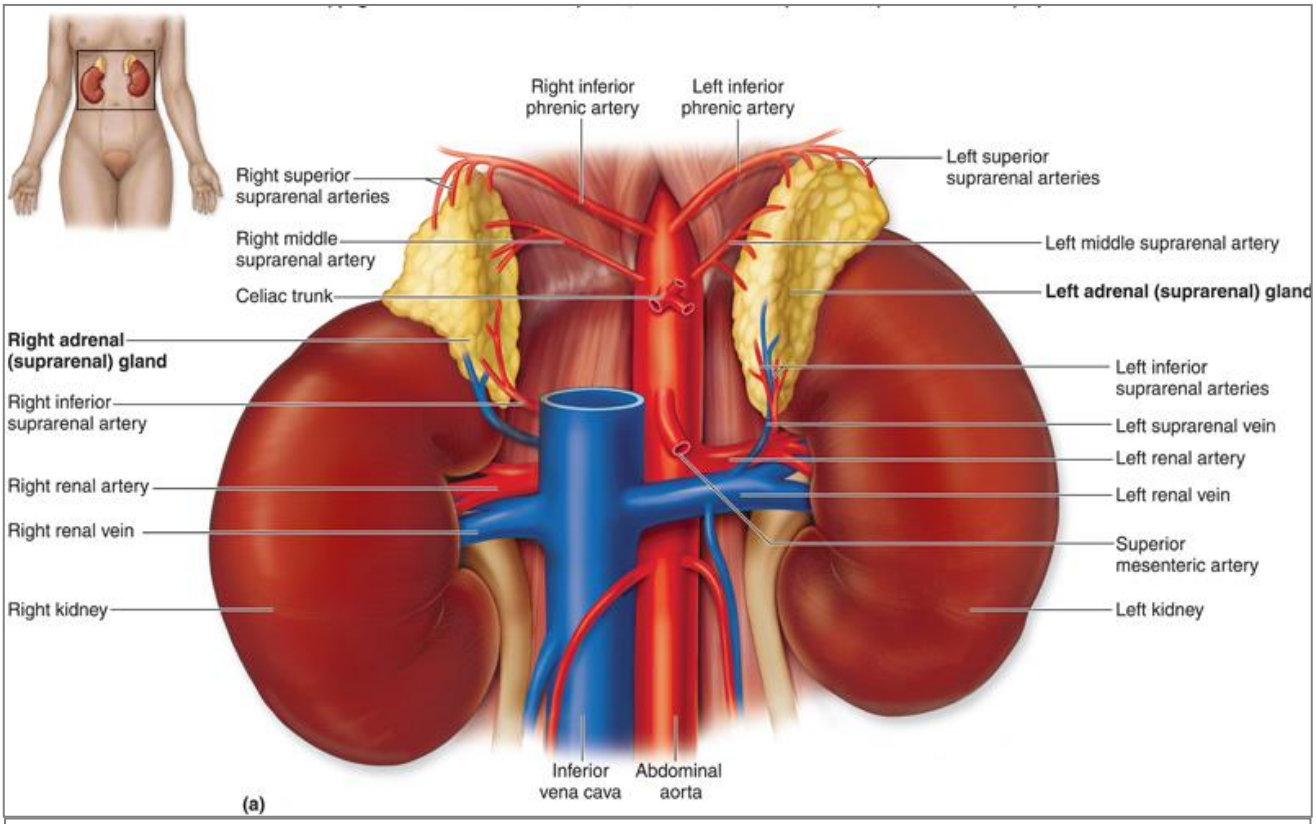
1. **Adrenal cortex** (Remember *GFR* from outer>inner)
   a. ***Zona glomerulosa:*** responsible for mineralocorticoids production **"Aldosterone".** The secretion is under the influence of renin aldosterone system **"angiotensin II".** Aldosterone acts on the distal renal tubules to increase the circulating blood volume by increasing sodium and chloride reabsorption, water retention, and potassium excretion.
   b. ***Zona fasciculata:*** produce glucocorticoids **"Cortisol".**
   ACTH **"Adrenocorticotropic hormone"** stimulates cortisol production by the anterior pituitary, which is stimulated by CRF **"corticotropin-releasing factor"** by the hypothalamus. Glucocorticoids induce the catabolic state in the body in response to stress, by increasing blood glucose concentration, stimulating lipolysis, enhancing adrenergic stimulation of the cardiovascular system, and reducing the inflammatory response of the immune system.
   c. ***Zona reticularis:*** produces the adrenal sex hormone androstenedione **"androgen"** and DHEA **"Dehydroepiandrosterone".**
2. **Adrenal medulla**

   The adrenal medulla produces catecholamines **"epinephrine and norepinephrine"** that act on peripheral alpha and beta-receptors.

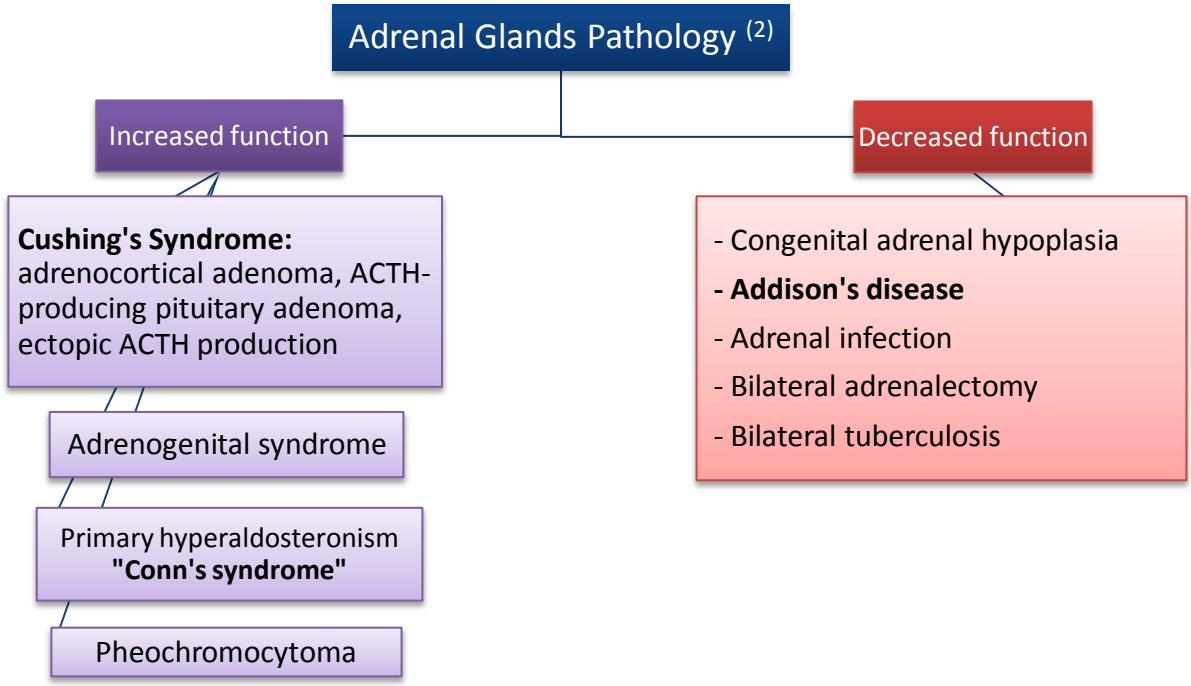
Note(s):

- Alpha-receptor stimulation produces peripheral vasoconstriction. Beta stimulation of the myocardium via β_1 receptors increases heart rate and contractility. Stimulation of peripheral β_2 receptors causes relaxation of smooth muscles [(1)].

- **Remember: Glucocorticoids** and **Androgens** are under hypothalamic control via **ACTH;** while **mineralocorticoids** are under the control of the **renin-angiotensin system** [(2)]



http://www.austincc.edu/rfofi/NursingRvw/NursingPics/EndocrinePics/adrenalglandlocation.jpg



Cushing's Syndrome

Cushing's syndrome is produced by increased circulating corticosteroids. The causes are: **exogenous therapeutic steroids administration "iatrogenic"** **"the most common cause",** pituitary adenoma producing ACTH resulting in adrenal hyperplasia **"Cushing's disease"**, about 10% are due to benign or malignant adrenocortical tumors, or rarely, ectopic ACTH production by distant tumor, e.g. carcinoma of the bronchus [2].

Clinical features [1]:

Hypertension, edema, muscle weakness, glucose intolerance, osteoporosis, easy bruising, cutaneous striae, and truncal obesity **(buffalo hump, moon face).**

Women may develop acne, hirsutism, and amenorrhea as a result of adrenal androgen excess.

Note(s):

- The most common cause of endogenous hypercortisolism is hypersecretion of ACTH from the anterior pituitary gland [1].

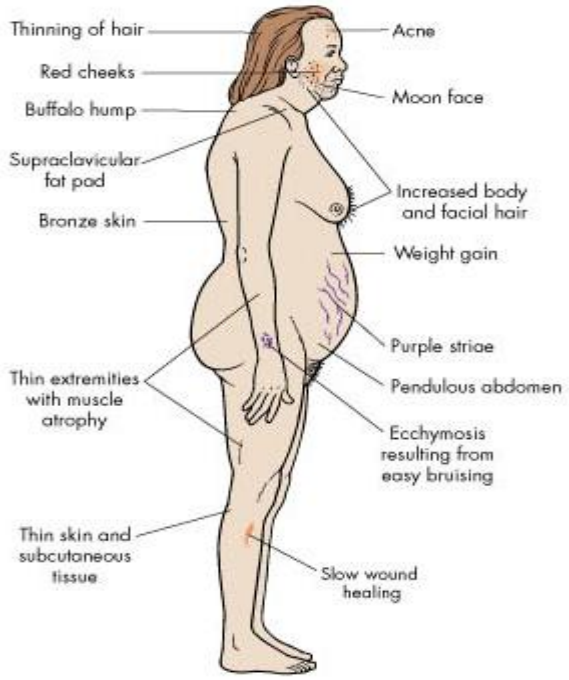


Figure 47-9 Common characteristics of Cushing's syndrome.

Remember:

Stress increase cortisol production and secretion!

Investigations [2]:

- **Urinary 24-hour cortisol level.**
- **Plasma cortisol level.**
- ***Dexamethasone* suppression test.**
- **Plasma ACTH.**
- **CT scan and MRI.**

Treatment [1]:

surgical treatment of Cushing's syndrome involves removing the cause of cortisol excess **(a primary adrenal lesion or pituitary or ectopic tumors secreting excessive ACTH).**

Conn's Syndrome

Primary hyperaldosteronism **"Conn's syndrome"** is a syndrome caused by hypersecretion of mineralocorticoid aldosterone, **which could be caused by [1]:**

- **An aldosterone-producing adrenal adenoma (APA) "the most common cause" and it is one of the few surgically correctable causes of hypertension.**
- **Idiopathic bilateral adrenal hyperplasia (IHA).**
- **Adrenocortical carcinoma.**

Clinical features [2]:

Low serum potassium **(which results in episodes of muscle weakness and paralysis)**, raised serum sodium, alkalosis together with hypertension. There may be also polyuria and polydipsia.

Investigations [2]:

- ✓ **Serum electrolytes (Hypokalemia and Hypernatremia).**
- ✓ **Plasma aldosterone**
- ✓ **Abdominal CT scan**
- ✓ **Selective angiography**

Treatment [2]: Laparoscopic adrenalectomy.

Addison's Disease

Primary adrenal insufficiency **"Addison's disease"** occurs when the adrenal glands can't produce an adequate amount of hormones despite a normal or increased ACTH level [3].

Note(s):

The type and severity of symptoms depends upon speed with which the condition develops, the severity of the hormone deficiency, and underlying cause of the condition, and other stresses on the body [3].

Clinical features [3]: generalized weakness, fatigue, hypotension, loss of appetite, weight loss, skin pigmentations (see below), nausea and vomiting, muscle and joint pain, and **salt craving.**

Note: Skin hyperpigmentation occurs because the melanocyte-stimulating hormone (MSH) and ACTH share the same precursor molecule. Skin darkening doesn't occur in secondary or tertiary adrenal insufficiency because ACTH is not overproduced.

Investigations [3]:

- ✓ Blood cortisol level
- ✓ ACTH level
- ✓ Abdominal CT scan
- ✓ Autoimmune antibodies presence

Treatment [3]: Hormonal replacement therapy.

Adrenalectomy

Pre-Op care:

- ✓ Stabilize the hormones
- ✓ Correct fluids and electrolytes
- ✓ Measure the cortisol level also during the surgery
- ✓ Control the blood pressure

Post-Op care [4]:

- ✓ Chemistry screen and complete blood count (CBC).
- ✓ Blood pressure monitoring
- ✓ Electrolytes monitoring
- ✓ Monitor the urine output
- ✓ **Cortisol supplements**

Pheochromocytoma

Pheochromocytomas are neoplasms derived from the chromaffin cells of the sympathoadrenal system that result in unregulated, episodic oversecretion of catecholamines [1].

Clinical features [1][2]: frontal headache, diaphoresis, palpitations, flushing, anxiety, **episodic or sustained hypertension** **"the most common sign",** blurred vision, and sweating.

The diagnostic traid:

1. **Headache, sudden in onset and pounding.**
2. **Tachycardia and/or palpitation.**
3. **Sweating.**

Investigations [1][2]:

- ✓ **24-hour urinary excretion of catecholamines and their metabolites**
- ✓ **Fasting plasma catecholamines**
- ✓ **CT scan or MRI**

Treatment [2]: Surgical excision and pre-operative alpha and beta-adrenergic blockers administration.

Note(s):

NEVER take a biopsy if pheochromocytoma was expected.

Adrenal Incidentaloma

It is an adrenal mass found incidentally after preforming an imaging producer "CT scan or MRI" unrelated to the adrenal glands [5]. Usually the patient has no signs or symptoms of malignancy or hormonal abnormality.

SUMMARY

1. The adrenal gland composed of:
   a. **Cortex**:
      Three specific zones and each produce a specific class of steroid hormone:

Zona Glomerulosa	(remember glomerulus)	Mineralocorticoids	**Aldosterone**	SALT
Zona Fasciculata	(remember Chocolata)	Glucocorticoids	**Cortisol**	SUGAR
Zona Reticularis	(be creative!)	Androgens		SEX

   b. **Medulla**: secrete epinephrine, norepinephrine, and a small amount of dopamine in response to stimulation by sympathetic preganglionic neurons.

2. Adrenal Pathologies:

Increased Function:
- Cushing Syndrome **(commonly iatrogenic)**
- Adrenogenital Syndrome
- Conn's Syndrome (1ary Hyperaldosteronism): Hypernatremia with Hypokalemia = Hypertenstion with alkalosis
- Pheochromocytoma: Neoplasm result in unregulated, episodic oversecretion of catecholamines. The most common sign in episodic or sustained hypertension.

Decreased Function:
- Congenital adrenal hypoplasia
- Addison's disease (1ary adrenal insufficiency)
- Adrenal infection
- Bilateral adrenalctomy
- Bilateral tuberculosis

IMPORTANT NOTES FROM EXTERNAL RESOURCES

(1)	The Washington Manual of Surgery 6th Edition, Chapter 21
(2)	General Surgery Lecture Notes 12th Edition, Chapter 40
(3)	http://www.uptodate.com/contents/adrenal-insufficiency-addisons-disease-beyond-the-basics#H1
(4)	http://www.nursingcenter.com/lnc/CEArticle?an=01271211-201011000-00006&Journal_ID=682710&Issue_ID=1080868
(5)	http://emedicine.medscape.com/article/116587-overview#a0101

Questions

1) Addison's Disease is associated with all except?
   a. Hyponatremia
   b. Hypoglycemia
   c. Sexual Dysfunction
   d. Mild Alkalosis

2) The release of Glucocorticoids is controlled by?
   a. Serum Sodium Level
   b. Serum Potassium Level
   c. Anterior pituitary gland
   d. Non of the above

3) The diagnosis of pheochromocytoma include all except?
   a. Biopsy
   b. 24 hour urine-VMA
   c. Plasma Catecholamines
   d. CT-Scan

Answers:

1st Questions: D

2nd Questions: C

3rd Questions: A