Hypertension

Objectives:

At the end of the lecture, the student should:

(1) Know the etiology, risk factors and complications of hypertension.

(2) Be able to identify patient risk factors amenable to treatment by lifestyle modification.

(3) Investigate patients appropriately for causes of secondary hypertension.

Editing file

Black: original content.
Red: Important.
Light Purple:From Robbin's.
Blue:only found in boys slides.

Green: Boy's doctor notes .
Dark orange: Girl's Doctor notes.
Grey: Explanation.
Pink: Only found in girls slides.

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MED438 KING SAUD UNIVERSITY

Pathology Teamwork 438

Hypertension (HTN)

Definition

A sustained Systolic pressure in excess of 140 mmHg or a sustained Diastolic pressure greater than 90 mmHg;Higher than (140/90)[1][2].

Epidemiology

- common disorder affecting 25% of the population
- a major risk factor for atherosclerosis, **congestive heart failure**(most common cause of death), and renal failure.
- At early stages of HTN there might be a few symptoms or it may be **asymptomatic (painless silent killer)**.
- Complications alert to diagnosis but late.

Hypertension is an important factor which contributes in development of:

- Coronary heart disease
- Cerebrovascular accidents (stroke)
- Cardiac hypertrophy
- Congestive heart failure
- Aortic dissection
- Renal failure
- Retinopathy

Risk Factors

- **Hereditary** — Family history, Genetics
- **Age &Gender** — Men & Postmenopausal women
- **Race** — African-Americans
- **Heavy alcohol consumption**
- **Oral contraceptives** [3]
- **Diabetes**
- **Obesity** — -Sedentary (inactive) lifestyle -Stress
- **Diet (sodium intake)**

1- However, these values are somewhat arbitrary, and in patients with other cardiovascular risk factors (e.g., diabetes), lower thresholds may be applicable.

2 - Blood pressure must be taken at least three different times.

3- Because of this women older than 40 are not given oral contraceptive, unless it's for other problems like uterine bleeding.

Classification of HTN

Hypertension is classified either by:

- **Clinical features**
- **Etiology & Cause**
  - **Primary / Essential HTN (95%)** — Mechanism Unknown (Idiopathic)
  - **Secondary (5-10%)** — Due to Pathology in the Renal, Endocrine, Vascular or Neurogenic systems

Benign

- The BP is at a modest level (not very High)
- It could be Idiopathic HTN or Secondary HTN.
- **Stable** over years to decades.
- Compatible with long life.

Malignant

Called "malignant" Because it may lead to death.

- Rapidly rising BP which often leads to **end organ damage.**
- can be a complication of any type of HTN (Essential or Secondary).
- It is seen in **5%** of the hypertensive patients.
- The diastolic pressure is usually over 120 mmHg
- It is associated with : (Kidney, Retina, Brain, Heart)
  - Widespread Arterial necrosis and thrombosis
  - Rapid development of Renal Failure
  - Retinal hemorrhage and exudate
  - Hypertensive encephalopathy
  - Left ventricular failure
  - Leads to death in 1 or 2 years if untreated.

Causes of secondary hypertension:

Endocrine:	★ *Renal:*	*Cardiovascular:*	*Neurologic:*
Adrenocortical hyperfunction (Cushing syndrome, primary aldosteronism, congenital adrenal hyperplasia, licorice ingestion) **Exogenous hormones** (glucocorticoids, estrogen [including pregnancy- induced and oral contraceptives], sympathomimetics and tyramine- containing foods, monoamine oxidase inhibitors) **Pheochromocytoma** ★ **Acromegaly** **Hypothyroidism** (myxedema) **Hyperthyroidism** (thyrotoxicosis) **Pregnancy-induced** (pre-eclampsia) ★	Acute glomerulonephritis Chronic renal disease Adult Polycystic disease Renal artery stenosis★ Renal vasculitis Renin-producing tumors	Coarctation of the aorta Vasculitis (Polyarteritis nodosa) Increased intravascular volume Increased cardiac output Rigidity of the aorta	Psychogenic Increased intracranial pressure Sleep apnea Acute stress, including surgery

Regulation Of Blood Pressure

There are 2 hemodynamic variables that are involved in the regulation of BP. They are Cardiac output and Peripheral vascular resistance.

BP = Peripheral Resistance x Cardiac output

Peripheral resistance

it is the resistance of the arteries to blood flow.How? As the arteries constrict, the resistance increases and as they dilate, resistance decreases.

Cardiac Output

is affected by blood volume and is dependent on sodium concentrations.
"CO=Stroke volume x Heart rate"

Peripheral resistance is regulated at the level of the Arterioles (also known as resistance vessels) and is determined by three factors:
(Peripheral resistance is regulated predominantly at the level of the arterioles by neural and humoral inputs)

1. **Autonomic activity**: Sympathetic activity constricts peripheral arteries.
2. **Pharmacologic agents**: vasoconstrictor drugs increase resistance while vasodilator drugs decrease it.
3. **Blood viscosity**: increased viscosity increases resistance.

Regulation Of Blood Pressure (BP)

Normal BP is maintained by a balance between multiple factors including;

1. **induce vasoconstriction** (e.g. angiotensin II and catecholamines).
2. **induce vasodilation** (e.g. kinins, prostaglandins, and nitric oxide).

Note: An increased blood flow in the arterioles induces vasoconstriction to protect tissues against hyperperfusion.

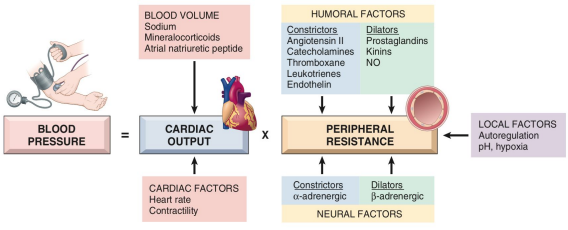


Fig. 10.3 Blood pressure regulation.

- **Endocrine Factors**: role of renin-angiotensin-aldosterone in regulating BP.

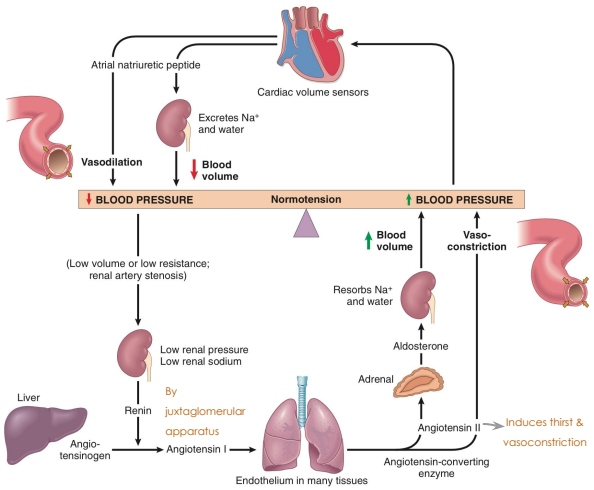


Fig. 10.4 Interplay of renin, angiotensin, aldosterone, and atrial natriuretic peptide in blood pressure regulation (see text).

- An elevated plasma renin level is typical of renovascular hypertension, which can occur with narrowing of a renal artery.
- Increased urinary catecholamines can indicate increased catecholamine output from a pheochromocytoma.

Pathogenesis Of Essential Hypertension

Essential HTN occurs when the relationship between cardiac output and peripheral resistance is altered. Multiple genetic and environmental factors ultimately increase the cardiac output and/or peripheral resistance

Genetic Factors

1-Defect in renal sodium homeostasis

Reduced renal sodium excretion is a key initiating event in most forms of essential hypertension. *How?* decreased sodium excretion → increased intravascular fluid volume (kidney retains Na and water) → increase in cardiac output thereby → elevated BP (due to increased peripheral vascular resistance).
This is usually due to defect in cell membrane function: affecting Na/Ca transport.
★ Defect in the control of salt&water balance is the key initiating event of hypertension.

2-Functional vasoconstriction

abnormality in vascular tone such as **increased sympathetic stimulation → vasoconstriction → increased peripheral resistance**.

3-Structural abnormality in vascular smooth muscle

(chronic vasoconstriction may result in permanent thickening of the walls of affected vessels.)

leads to increased peripheral resistance.

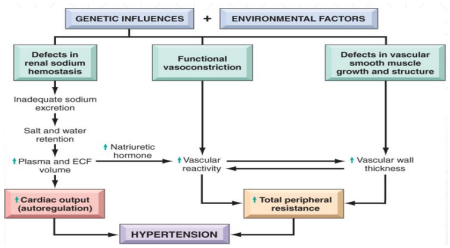
4-rare gene disorders can cause HTN

-By increasing renal sodium reabsorption e.g. Liddle syndrome: an inherited autosomal dominant type of HTN that begins in childhood. It is caused by mutations of the **epithelial sodium channel protein (ENaC)** → increased sodium reabsorption in the renal tubules (followed by water) → hypertension.
-Reabsorption of sodium also correlates with potassium loss (hypokalemia) "Hypertensive patients with hypokalemia can also have hyperaldosteronemia, which can be caused by an aldosterone-secreting adrenal adenoma.".

Environmental factors

- stress
- obesity
- smoking
- physical inactivity
- heavy consumption of salt

NOTE: In hypertension, both increased blood volume and increased peripheral resistance contribute to the increased pressure. However reduced renal sodium excretion in the presence of normal arterial pressure (initially) is probably a key initiating event



Atrial natriuretic peptide(ANP) / factor / hormone (Cardionatrine / Cardiodilatine / atriopeptin)

Definition

It is a protein (polypeptide) hormone secreted by the heart muscle cells in the atria of heart (atrial myocytes).

Function

powerful **vasodilator** and is involved in the homeostatic balance of body water, sodium, potassium and fat.

Why is it released?

in response to high blood volume. It acts to reduce the water, sodium and adipose loads on the circulatory system, thereby reducing blood pressure.

It has the exact opposite function of aldosterone secreted by the zona glomerulosa (The most superficial layer of the adrenal cortex).

Effects On Organs	**In the kidney :** • Decreases sodium reabsorption and increases water loss. • Inhibits renin secretion, thereby inhibiting the renin–angiotensin–aldosterone system
	In adrenal gland : • Reduces aldosterone secretion by the zona glomerulosa of the adrenal cortex.
	In arterioles : • Promotes vasodilation
	In adipose tissue : • Increases the release of free fatty acids from adipose tissue.

Morphology of blood vessels

Morphology of blood vessels in HTN

Small Blood Vessels (Microangiopathy): Arteriosclerosis

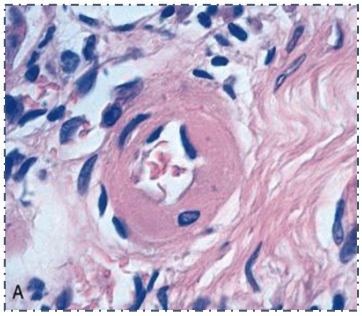
large Blood Vessels (Macroangiopathy)

Atherosclerosis.

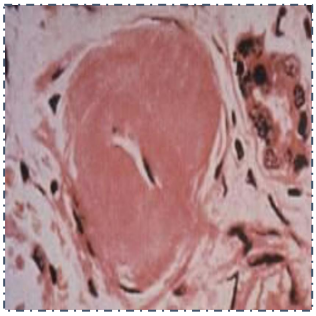
*HTN is a major modifiable risk factor in AS.

★Hyaline arteriolosclerosis

- Seen in **benign hypertension**
- Can be seen in **elderly** and **diabetic** patients even without hypertension.
- Can cause diffuse renal ischemia which ultimately leads to benign nephrosclerosis



Hyaline arteriolosclerosis: hyalinosis of arteriolar wall with narrowing of lumen.

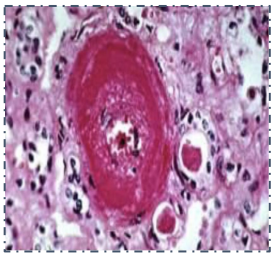


Hyaline/ Benign hypertension

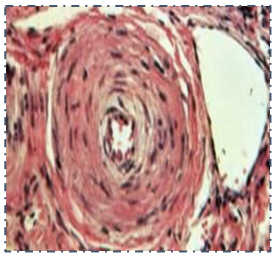
The small lesions that are supplied by these vessels will eventually undergo necrosis, which cases tiny "mosquito bite-like lesions" .

★ Hyperplastic arteriolosclerosis

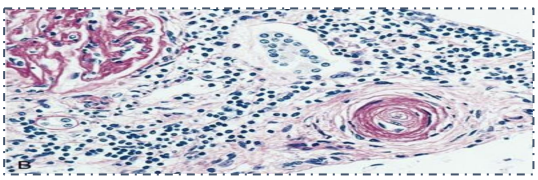
- Characteristic of **malignant hypertension**.
- Can show onion-skinning on histology causing luminal obliteration (loss) of vascular lumen
- May be associated with **necrotizing arteriolitis** and **fibrinoid necrosis** of the blood vessel.



Hyperplastic/ Malignant hypertension showing fibrinoid necrosis.



Hyperplastic/ Malignant hypertension showing onion skinning



Hyperplastic arteriolosclerosis (onion skinning) causing luminal obliteration of vascular lumen.

Complications

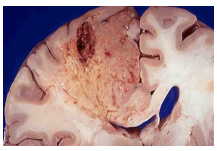
Complications of HTN:

Cardiovascular

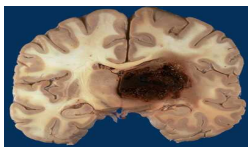
- **Left ventricular cardiac hypertrophy.***
- Coronary heart disease.
- Aortic dissection.

Brain

- Hemorrhage
- Infarction leading to Cerebrovascular accidents (Stroke)



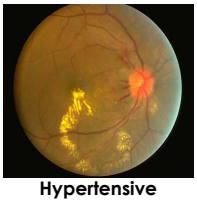
Cerebral infarction



Cerebral hemorrhage

Eyes

- Hypertensive retinopathy is especially **seen in malignant hypertension**.



Hypertensive retinopathy

Benign nephrosclerosis

Kidney

- Benign nephrosclerosis.
- Renal failure in untreated or on malignant hypertension.

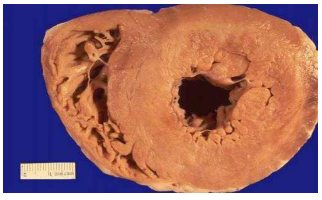
*Left[1] ventricular cardiac hypertrophy[2]:

- Also known as left sided hypertensive cardiomyopathy/ hypertensive heart disease.

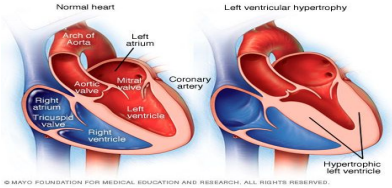
Why does it happen?

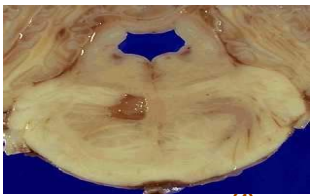
- Longstanding poorly treated HTN will lead to left sided hypertensive heart disease[3].
- **Hypertrophy** of the heart is an adaptive response to pressure overload due to chronic HTN.

Hypertension **INDUCES** Left ventricular pressure overload **LEADS TO** Hypertrophy of left ventricle, increase in heart weight (>500g),and LV wall thickness (>2cm)

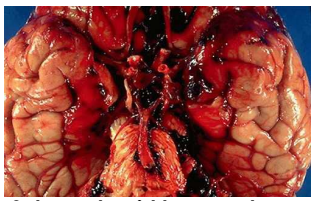


Left ventricular hypertrophy





Lacunar infarct[4]



Subarachnoid haemorrhage

(1): Why left? Because it is the part of the heart the sends blood out to the rest of the body.
(2): hypertrophy due to increased demand
(3): can eventually lead to left sided heart failure → pulmonary hypertension → right sided heart failure.
(4): very small infarct in the brainstem, although it is very small, it leads to death due to its sensitive location.

Summary

Risk factors: hereditary, race, gender, age, obesity, diet, stress, alcohol intake, diabetes, oral contraceptives, inactive lifestyle

Hypertension (HTN)
classified based on:

Etiology or Cause

95% Primary/Essential Hypertension → idiopathic

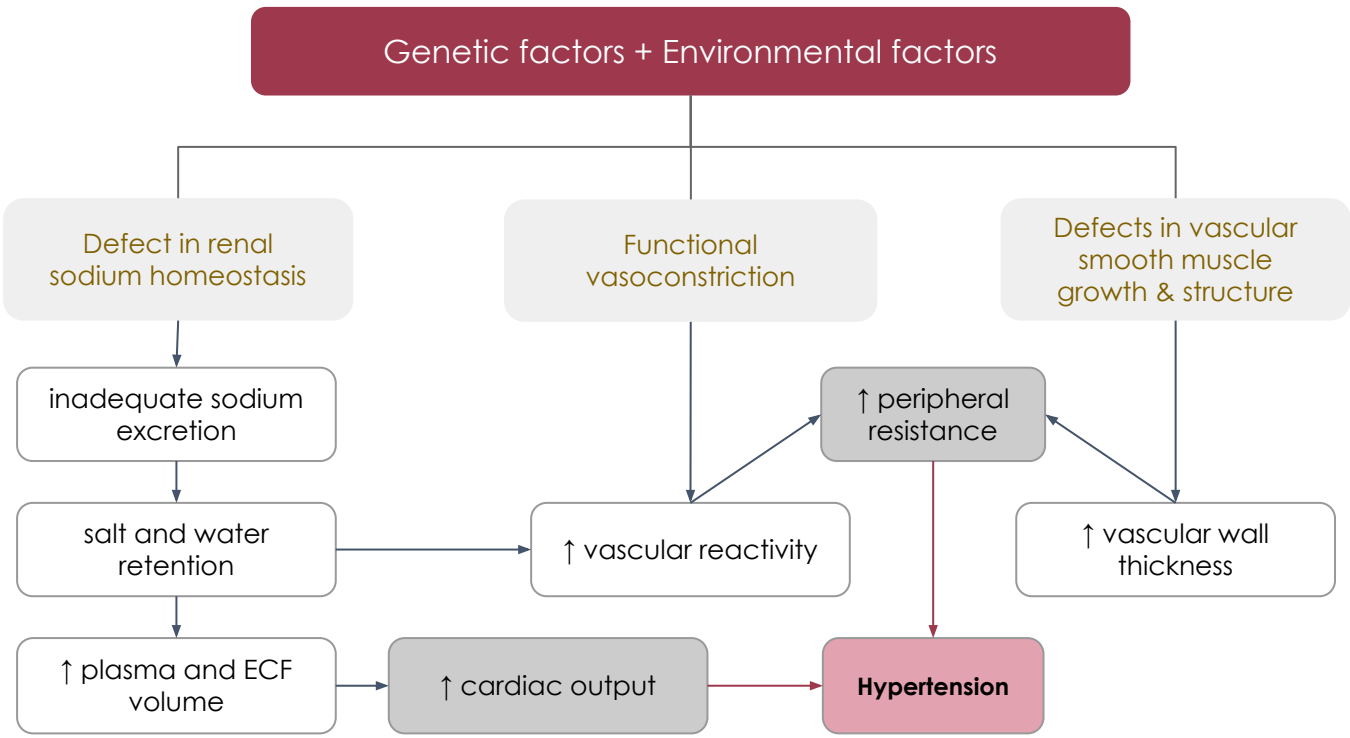
5-10% Secondary Hypertension → due to pathology in the renal, endocrine, vascular or neurogenic systems

Clinical Features

Benign
- BP at modest level.
- can be primary or secondary HTN.
- fairly stable.
- compatible with long life.

5% Malignant
- rapidly rising BP.
- can be a complication of primary or secondary HTN.
- diastolic pressure is over 120 mmHg.
- associated with widespread necrosis, renal failure, retinal hemorrhage, encephalopathy & LV failure.
- death in 1 or 2 years if untreated.

Pathogenesis of Primary Hypertension



Quiz

Answer key: Answers Explanation File

6) B ;5) A ;4) B ;3) D ;2) C ;1) D

1) A 72-year-old man presents with difficulty breathing. He says that he becomes short of breath at night unless he uses three pillows to prop himself up. Measurements of vital signs reveal normal temperature, mild tachypnea, and a blood pressure of 180/100 mm Hg. Physical examination discloses obesity, bilateral 2+mm pitting leg edema, hepatosplenomegaly, and rales at the bases of both lungs. An X-ray film of the chest shows mild enlargement of the heart and a mild pleural effusion. Echocardiography reveals left ventricular hypertrophy without valvular heart defects. Which of the following is the most likely diagnosis?

A) Acute cor pulmonale

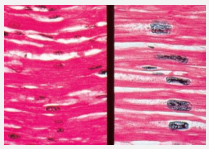
B) Constrictive pericarditis

C) Dilated cardiomyopathy

D) Hypertensive heart disease

E) Renal failure

2) A 68-year-old woman with metastatic breast cancer develops multiple organ dysfunction and dies. The heart at autopsy weighs 380 g (normal = 230 to 280 g in women). The patient's myocardium (right) is compared to normal myocardium (left). These pathologic findings are mostly likely due to which of the following conditions?



A) Amyloidosis.

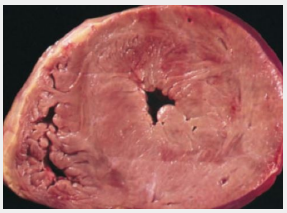
B) Chemotherapy.

C) Hypertension.

D) Inflammation.

E) Ischemia.

3) The illustration shows a section of the heart from a 45-year-old African-American man with long-standing hypertension who died of a "stroke." Which of the following adaptive changes is exemplified in the illustration?



A) Aplasia.

B) Atrophy.

C) Hyperplasia.

D) Hypertrophy.

E) Hypoplasia.

4) A 45-year-old woman is investigated for hypertension and is found to have enlargement of the left kidney. The right kidney is smaller than normal. Contrast studies reveal stenosis of the right renal artery. The size change in the right kidney is an example of which of the following adaptive changes?

A) Aplasia.

B) Atrophy.

C) Hyperplasia.

D) Hypertrophy.

E) Metaplasia.

5) For more than a decade, a 45-year-old man has had poorly controlled hypertension ranging from 150/90 mm Hg to 160/95 mm Hg. Over the past 3 months, his blood pressure has increased to 250/125 mm Hg. Laboratory studies show that his serum creatinine level has increased during this time from 1.7 mg/dL to 3.8 mg/dL. Which of the following vascular lesions is most likely to be found in this patient's kidneys?

A) Hyperplastic arteriolosclerosis.

B) Granulomatous arteritis

C) Fibromuscular dysplasia

D) Polyarteritis nodosa

E) Hyaline arteriolosclerosis

6) A 68-year-old man has had progressive dyspnea for the past year. An echocardiogram shows that the left ventricular wall is markedly hypertrophied. A chest radiograph shows pulmonary edema and a prominent left-sided heart shadow. Which of the following conditions has most likely produced these findings?

A) Centrilobular emphysema

B) Systemic hypertension

C) Tricuspid valve regurgitation

D) Chronic alcoholism

E) Silicosis

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THANK YOU