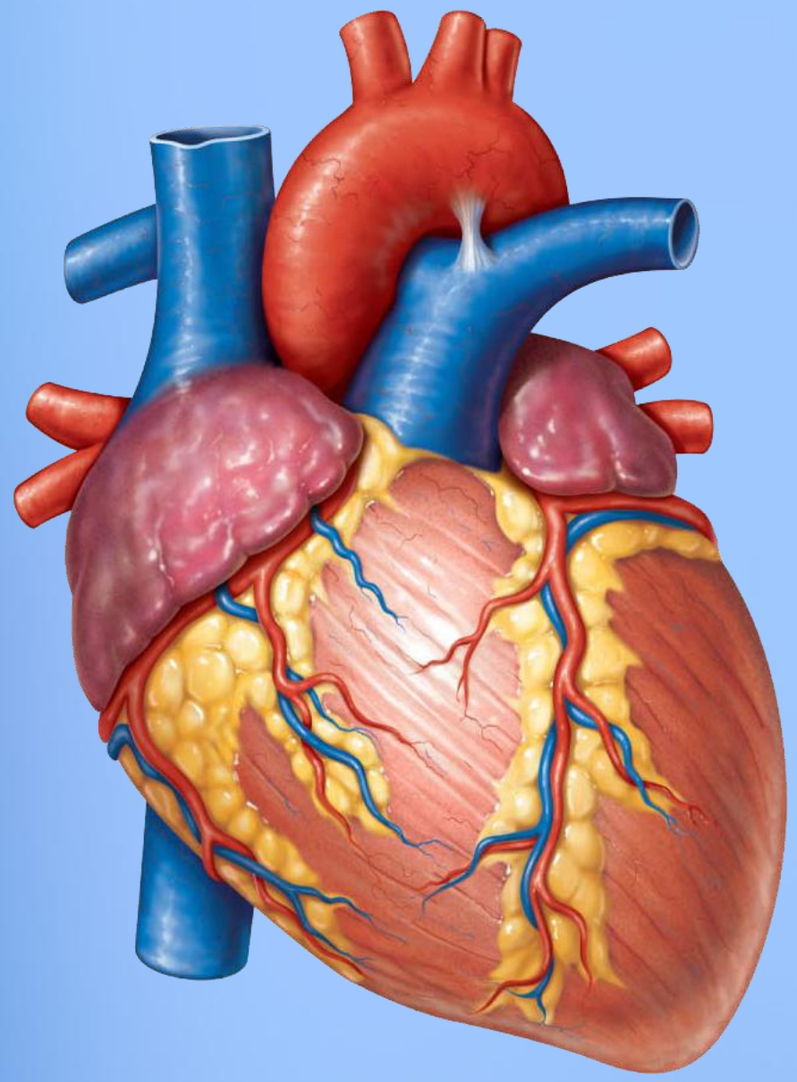
15

CORONARY CIRCULATION



Cardiovascular Block

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OBJECTIVE

- ✓ **Coronary Arteries**
- ✓ **Coronary blood flow**
- ✓ ***Understand The function of coronary arteries***
- ✓ ***What is happing* during Cardiac cycle**
- ✓ **Knowing the factors that affecting coronary blood flow**
- ✓ **Knowing the most vulnerable portion of the heart to ischemia**
- ✓ **Risk factors for coronary artery disease**
- ✓ ***coronary artery disease and it's effect on coronary blood flow***

CORONARY ARTERIES

❖ The major vessels of the coronary circulation are:

1

- **left main coronary artery**
  that divides into left **anterior descending** and **circumflex branches**

2

- **right main coronary artery**

❖ The left and right coronary arteries originate at the base of the aorta from openings called the coronary ostia located behind the aortic valve leaflets.

CORONARY BLOOD FLOW

- **The right coronary** artery has a greater flow in **50%** of population.
- **The left** has a greater flow in **20%** .
- Flow is **equal in 30%.**
- Coronary blood flow at rest in humans = **250 ml/min (5% of cardiac output)**
- **Venous blood**: Most of the venous drainage of the heart returns through the **coronary sinus** and **anterior cardiac veins**.
- At rest the heart extracts **60-70% of oxygen** from blood delivered to the heart , is very high right !! Then why is it high at rest ?

Because , Heart muscle has more mitochondria (40% cell volume) that generate energy for cardiac contraction by aerobic metabolism.

- coronary blood flow **increases** when more **O2 is needed**

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THE FUNCTION OF CORONARY ARTERIES

- The coronary arteries supply blood flow to the heart, and when functioning normally, they ensure adequate oxygenation of the myocardium at all levels of cardiac activity

HOW CAN *CORONARY ARTERIES DILATED OR CONSTRICTED ?*

- Constriction and dilation of the coronary arteries, governed primarily by **local regulatory mechanisms**, regulate the amount of blood flow to the myocardium

CORONARY BLOOD FLOW DURING CARDIAC CYCLE

1. Most of the coronary flow occurs **during diastole**.
2. When the **aortic pressure is increasing** the **coronary blood flow also increased**
3. When extravascular compression is happening

Extravascular compression during systole

markedly **reduces coronary flow** and at low coronary perfusion

the **endocardium** is more susceptible to **ischemia**

- **Tachycardia** shortens coronary filling time during diastole , why? Because the heart is beating too fast and this is particularly significant in patients with **coronary artery disease where coronary flow is reduced**

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FACTORS AFFECTING CORONARY BLOOD FLOW

They are three

1- Chemical factors:

Adenosine;-

An important mediator of active hyperemia and autoregulation

Nitric oxide;-

coronary vasodilator

Other chemical factors;-

hypoxia, excess CO2, H+, lactic acid

2-Autoregulation:

3-Nervous regulation:

Sympathetic activation

Parasympathetic activation

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FACTORS AFFECTING CORONARY BLOOD FLOW

2-Autoregulation

Flow is tightly coupled to oxygen demand. This is necessary because the heart has a very high basal **oxygen consumption** (8-10 ml O2/min/100g).

❖ oxygen consumption

In **non-diseased** coronary vessels, whenever cardiac activity and oxygen consumption **increases**, there is an **increase in coronary blood flow** (active hyperemia) that is nearly proportionate to the increase in oxygen consumption.

❖ The range of good autoregulation

Normal range between **60 and 200** mmHg perfusion pressure helps to maintain normal coronary blood flow whenever **coronary perfusion pressure changes** due to changes in **aortic pressure**

FACTORS AFFECTING CORONARY BLOOD FLOW

3- Nervous regulation

❖ Sympathetic activation to the heart results in

coronary vasodilation → **increased coronary flow** → **due to increased metabolic activity (increased heart rate, contractility).**

❖ Parasympathetic activation of the heart results in

Decrease heart rate → **decrease in myocardial oxygen demand** → **and so decreases coronary blood flow**

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THE MOST VULNERABLE PORTION OF THE HEART TO ISCHEMIA

Because there is no blood flow during systole in the **subendocardial portion of the left ventricle**, this region is prone to **ischemic damage** and is the most common site of **myocardial infarction**.

- In stenotic aortic valves patients the Blood flow to the left ventricle is decreased , **why ?** because in aortic stenosis **the pressure in the left ventricle must be much higher than that in the aorta to eject blood**. Consequently, coronry vessels are severely **compressed during systole.**

- **stenotic aortic valves patients** are more prone to develop myocardial ischemia.

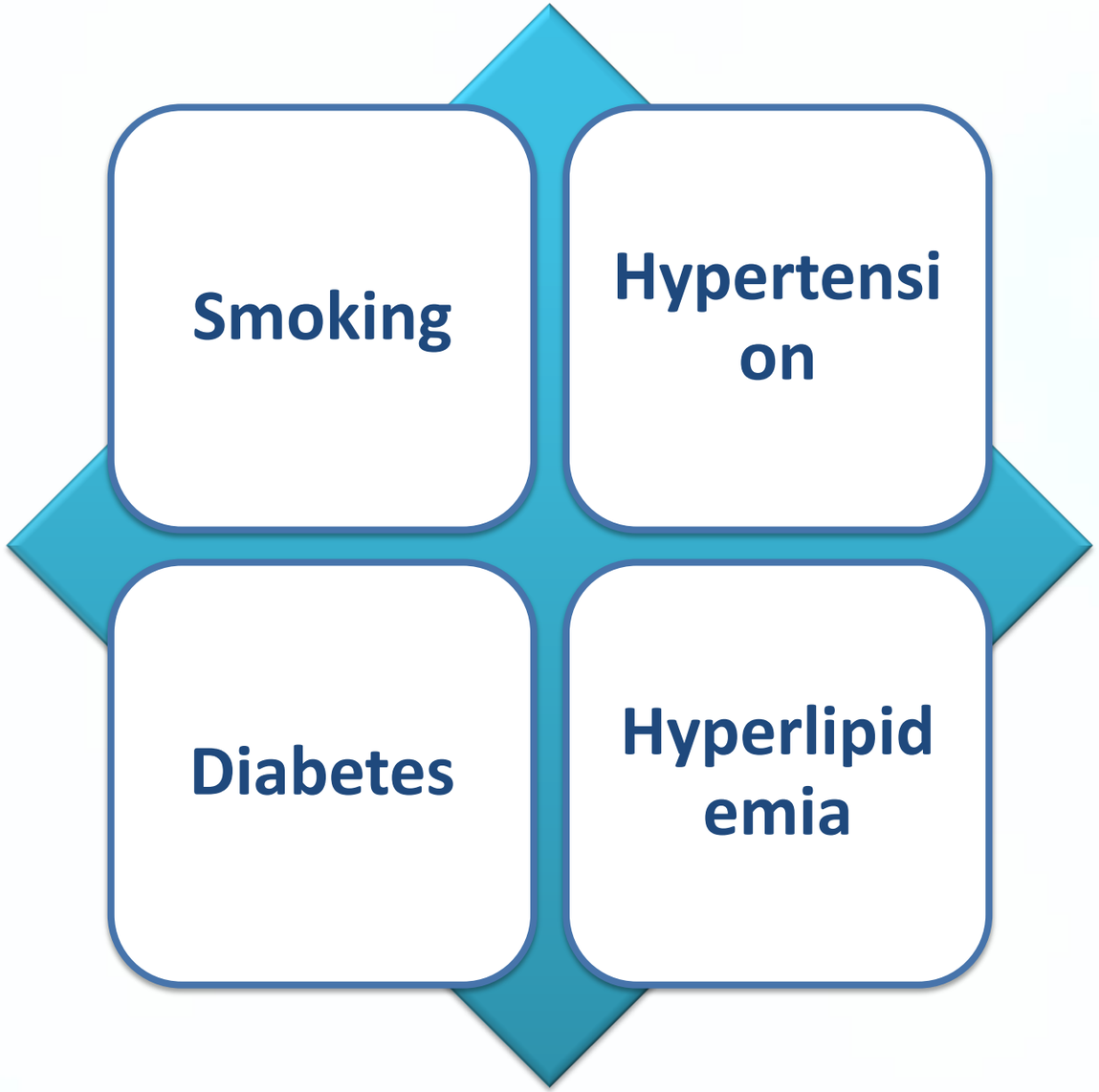
OXYGEN CONSUMPTION BY THE HEART AND ENERGY SUBSTRATE

- At rest, O2 consumption by beating heart = 9 ml/100 g/min.

- During ecxserise increases in myocardial O2 consumption are met by increases in CBF.

- O2 consumption by the heart is determined by:
  1. Intra-myocardial tension.(pressure)
  2. Contractile state of the myocardium.(contraction)
  3. Heart rate.
  - An **increase in afterload causes greater increase in O2 than an increase in preload does**. This is why angina due to deficient delivery of O2 to the myocardium is more common **in aortic stenosis than in aortic regurge**

RISK FACTORS FOR CORONARY ARTERY DISEASE



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CORONARY ARTERY DISEASE (CAD)

- CAD causes changes in both structure and function of the blood vessels.

- **Atherosclerotic processes** cause an abnormal deposition of lipids in the vessel wall :-

1. leukocyte infiltration
2. vascular inflammation
3. plaque formation
4. thickening of the vessel wall

These four changes lead to a narrowing of the lumen (i.e., stenosis), which restricts blood flow.

CORONARY ARTERY DISEASE (CAD)

- There are also subtle, yet **functionally important changes** that can occur **before overt changes in structure are observed**

- Early in the disease process, the endothelial cells that line the coronary arteries become dysfunctional , **why ?**

1. Because the endothelium produces important substances such as nitric oxide and prostacyclin that are required for normal coronary function, endothelial dysfunction can lead to coronary vasospasm, impaired relaxation,

2. formation of blood clots that can partially or completely occlude the vessel.

EFFECT OF CORONARY DISEASES ON CORONARY BLOOD FLOW

- In the presence of coronary artery disease, **coronary blood flow may be reduced**. This leads to tissue **hypoxia and angina**. If the lack of blood flow is due to a fixed **stenotic lesion** in the coronary artery (because of atherosclerosis), blood flow can be improved within that vessel by ?!

1. placing a stent within the vessel to expand the lumen
2. using an intracoronary angioplasty balloon to stretch the vessel open
3. bypassing the diseased vessel with a vascular graft

- If the insufficient blood flow is caused by **a blood clot (thrombosis),** a **thrombolytic drug** that dissolves clots may be administered and **Anti-platelet drugs to prevent the reoccurrence of clots**

- If the reduced flow is due to coronary vasospasm, **then coronary vasodilators can be given** (e.g., nitrodilators, calcium-channel blockers) **to reverse and prevent vasospasm.**

MCQs

1-Which of the following statement is true?

A. **The right coronary artery has a greater flow in 20% of population.**
B. **The left coronary artery has a greater flow in 50% of population.**
C. **Flow is equal in 30%.**
D. **Flow is equal in 50%.**

2-Which of the following is the reason of that "coronary arteries extracts about 70% of O2":

A. **Heart muscle has many mitochondria**
B. **Vessels of coronary arteries is large in diameter**
C. **The viscosity of blood is very low**
D. **All of them**

3-Most of the coronary flow occurs during:

A. **systole**
B. **Diastole**
C. **Systole and diastole**

4-Which of the following can be a factor that reduce coronary blood flow?

A. **Tachycardia**
B. Bradycardia
C. Intravascular compression
D. Filling of the heart chambers

5-Due to autoregulation the normal coronary perfusion pressure will be :

A. **between 120 and 180 mmHg**
B. **between 60 and 200 mmHg**
C. **between 60 and 90 mmHg**
D. **between 100 and 250 mmHg**

6-Which of the following chemical factors is a vasodilator?

A. **Thromboxane A**
B. **Vasopressin**
C. **Catecholamine**
D. **Nitric Oxide**

7-the most common site of myocardial infarction

A. **Pericardium**
B. **Supendocardial**
C. **Supmyocardial**
D. **Myocardium**

8-If the reduced flow is due to coronary vasospasm, then the drug that can be given:

A. **thrombolytic drug**
B. **Aspirin**
C. **calcium-channel blockers**
D. **Heparin**

1- C	2- A	3-B	4-A
5-B	6-D	7-B	8-C

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