Subject: CVS – Pathology

Topic: Ischemic heart disease 1+2

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Ischemic heart disease (IHD):

Heart disease is the leading cause of morbidity and mortality worldwide.

a group of related syndromes resulting from **myocardial ischemia** (an imbalance between cardiac blood supply (perfusion) and myocardial oxygen demand) **=>** Normally there is a balance between blood supply and oxygen demand of the heart. Myocardial ischemia occurs when there is **decrease in blood supply** (atherosclerosis, coronary vasospasm, hypovolemia, shock) or **increase in oxygen demand** (exertion, hypertension, stress, tachycardia) of the heart.

IHD ≈ coronary artery disease (CAD)

Ischemia can result from: 1- reduction in coronary blood flow -- atherosclerosis (90 % of cases) 2- increased demand (e.g., tachycardia or hypertension) 3- diminished oxygen-carrying capacity (e.g., anemia, CO poisoning)

Angina pectoris	Angina pain (a crushing or squeezing substernal pain) Possible areas of radiating pain: neck, jaw, upper abdomen, shoulders and arms angina causes intermittent chest pain caused by **transient reversible myocardial ischemia** (ischemia causes pain but is insufficient to lead to death of myocardium) ***pain <20 minutes and relieved by rest or nitroglycerin*** [compared to MI in which pain lasts > 20 minutes to several hours and is not relieved by nitroglycerin or rest]	**Stable angina (**classic angina/ effort angina/ typical angina**)** → Critical coronary stenosis → associated with critical atherosclerotic narrowing → **Episodic** pain only with increased demand → forms of ↑ myocardial oxygen demand (e.g. **exertion**; tachycardia; hypertension; fever; anxiety; fear) → ***relieved by rest*** (reducing demand) or by drugs (e.g. nitroglycerin) **Unstable angina (**Crescendo angina**)** → critical stenosis with superimposed Acute Plaque Change: 1-plaque disruption 2- partial thrombosis (non-occlusive) 3- distal embolization 4-vasospasm → **increasing frequency** of pain, precipitated by **less** exertion. → more **intense** and **longer** lasting than stable angina → Usually precedes more serious, potentially irreversible ischemia, thus it is called: ***pre-infarction angina*** **Variant angina (**Prinzmetal angina**)** → severe coronary vasospasm → Vessels without atherosclerosis can be affected → Etiology not clear → **occur at rest or sleep** → Treatment: vasodilators (nitroglycerin or calcium channel blockers)

Acute myocardial infarction (MI)
= heart attack

the severity or duration of ischemia is enough to cause cardiac muscle death (**necrosis of heart muscle due to ischemia**) a significant cause of death worldwide

Clinical features:

1- severe, crushing substernal pain that radiates to neck, jaw, epigastrium, or left arm
2- dizziness; sweating
3- rapid and weak pulse
4- nausea (in posterior MI)
5- dyspnea (if pulmonary congestion and edema)
6- cardiogenic shock (in massive MIs >40% of left ventricle)

Sometimes: no typical symptoms (silent infarcts) = a variable percentage of MIs are **asymptomatic**/ confirmed only on ECG and lab workup/ particularly in **DM** (peripheral neuropathies) + **the elderly**

Causes

Acute occlusion of the **proximal left anterior descending (LAD) artery** is the cause of 40% to 50% of all MI cases

Consequences and complications

1- Death

***50%** occur before reaching hospital (within 1 hour of symptom onset-usually as a result of lethal arrhythmias (**Sudden Cardiac Death**)) – ventricular arrhythmia
* Arrhythmias are caused by electrical abnormalities of the ischemic myocardium and conduction system
* With current medical care, patient outcome is better (**in-hospital** death rate has declined)

2- cardiogenic shock

15% - In large infarcts (>40% of Left ventricle). 70% mortality rate - important cause of in-hospital deaths.

3- myocardial rupture

rupture of the ventricular free wall: hemopericardium and cardiac tamponade (usually fatal)
rupture of the ventricular septum: VSD and left-to-right shunt
papillary muscle rupture: severe mitral regurgitation

Evolution

→ Zone of perfusion = area at risk of ischemia
→ Obstructed coronary artery is beneath the pericardium/ overlaying the myocardium
→ Zone of necrosis starts after >30m at the subendocardial area of myocardium
The endocardium is spared of necrosis
After 24hr, zone of necrosis = zone of perfusion

1- clinical signs and symptoms
2- electrocardiographic (ECG) abnormalities
3- laboratory evaluation: blood levels of intracellular macromolecules that leak out of injured myocardial cells through damaged cell membranes.
Cardiac enzymes (markers) in MI: myoglobin, cardiac troponins T and I (TnT, TnI), creatine kinase (CK) specifically the myocardial-specific isoform (CK-MB), lactate dehydrogenase

- ✓ Cardiac troponins T and I (TnT, TnI), are the best markers for acute MI. **[very specific for cardiac muscles, stays elevated for a long period of time following acute MI]**
- ✓ Creatine kinase CK-MB is the second best marker after the cardiac-specific troponins.

Microscopic features **[not part of the diagnostic process]**

<24 hr: coagulation necrosis and wavy fibers, necrotic cells are separated by edema fluid **[H&E]**

2-3 days: dense neutrophil infiltrate **[H&E]**

7-10 days: complete removal of necrotic myocytes by macrophages **[H&E]**

Up to 14 days: granulation tissue [loose connective tissue (blue) and abundant capillaries (red)] – **beginning of the repair phase** **[Masson Trichrome - MT]**

Several weeks: healed infarct consisting of dense collagenous scar (blue) **[Masson Trichrome - MT]**

4- pericarditis: 2 to 3 days post a transmural MI, spontaneously resolves (immunologic mechanism)

5- infarct expansion: disproportionate stretching, thinning, and dilation of the infarct region (especially with anteroseptal infarcts)

6- mural thrombosis: loss of contractility (causing stasis) + endocardial damage → thromboembolism

7- ventricular aneurysm: A late complication, most commonly result from a large transmural anteroseptal infarct that heals with the formation of thin scar tissue -- Complications of ventricular aneurysms include: 1-mural thrombus 2-arrhythmias 3-heart failure

8- progressive late heart failure

Long-term prognosis after MI depends on many factors e.g. left ventricular function; severity of atherosclerosis in viable myocardium; etc... -**1st year mortality ≈ 30%.** -**Thereafter, the annual mortality rate≈ 3%**

Chronic IHD	results from **post-infarction** cardiac decompensation that follows exhaustion of hypertrophic viable myocardium. [progressive cardiac decompensation (heart failure) following MI] **progressive heart failure** sometimes punctuated by episodes of angina or MI Arrhythmias are common
Sudden cardiac death (SCD)	Unexpected death from cardiac causes either without symptoms or < 24 hours of symptom onset **CAD (atherosclerosis) is the most common underlying cause** **Lethal arrythmias (v. fibrillation) is the most common direct mechanism of death** With **younger** victims, other non-atherosclerotic causes are more common – hereditary/ acquired abnormalities of cardiac conduction system (for more causes refer to IHD 2 / slide 22)