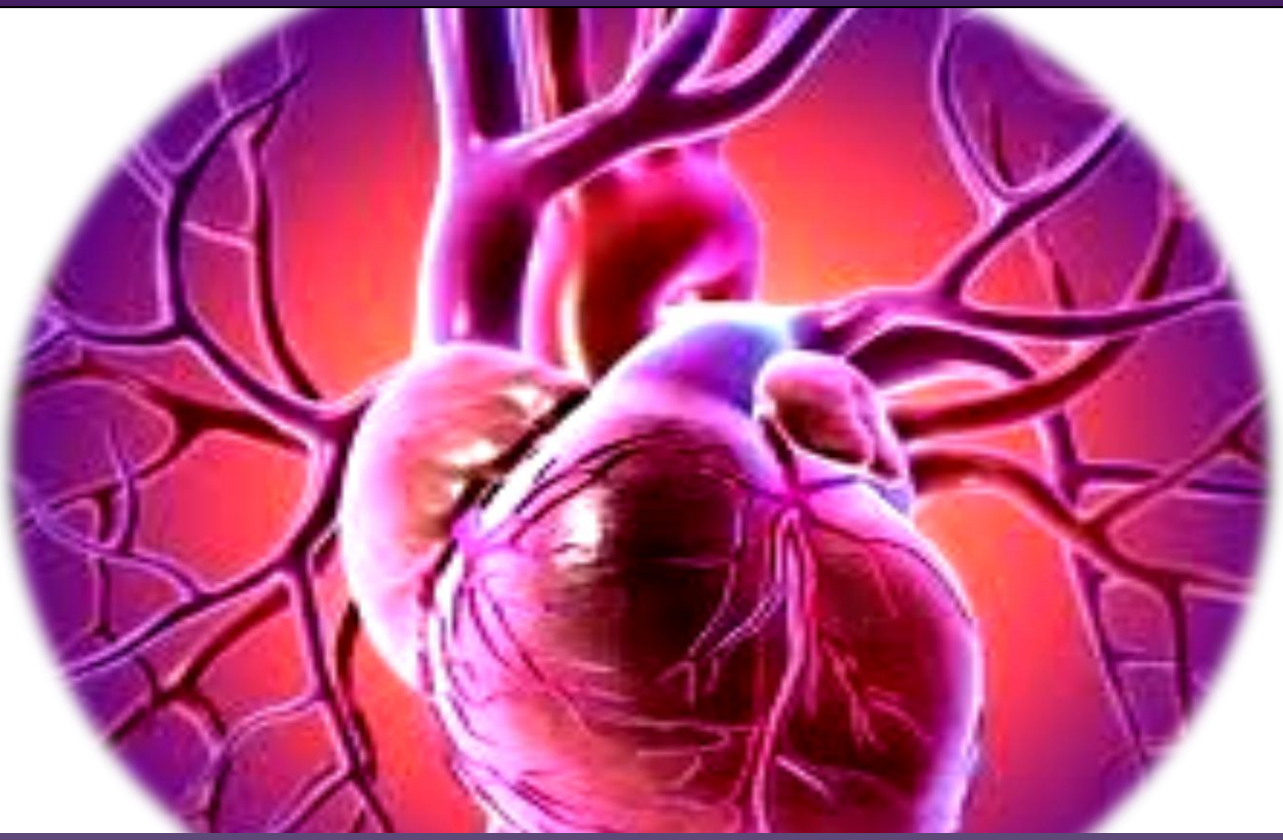
Cardiovascular system block

Pathology team 431



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Bayan al-nooh

Wala'a al-shehri

Reema al-anezi

Hassah al-fozan

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2nd lecture

Ischemic Heart Disease

Ischemic Heart Disease

A group of related syndromes resulting from myocardial *ischemia*

It is an imbalance between cardiac blood supply (perfusion) and myocardial oxygen demand

Ischemic Heart Disease

- The vast majority of ischemic heart diseases are due to coronary artery atherosclerosis

So it will reduce blood flow from coronary artery to heart.

- Less frequent contributions of:
  - vasospasm
  - vasculitis

  Is it exactly the same as coronary artery disease (CAD)?

  Frequently yes

IHD usually presents as one or more of the following clinical syndromes:

1. **Myocardial infarction,** the most important form of IHD, in which ischemia causes the death of heart muscle.
2. **Angina pectoris (literally chest pain)**

In which the ischemia is of insufficient severity to cause infarction, but may be a harbinger (lead to) of MI (myocardial infarction).

3. **Chronic IHD** with heart failure.
4. **Sudden cardiac death.**

These syndromes are all relatively late manifestations of coronary atherosclerosis that begin early in life but manifest only after the vascular occlusions reach a certain stage

Ischemic Heart Disease

- **75%** stenosis = →**symptomatic ischemia induced by exercise**

  The manifestation will show up during exercise (because we need more O2)

- **90%** stenosis = symptomatic even at **rest**

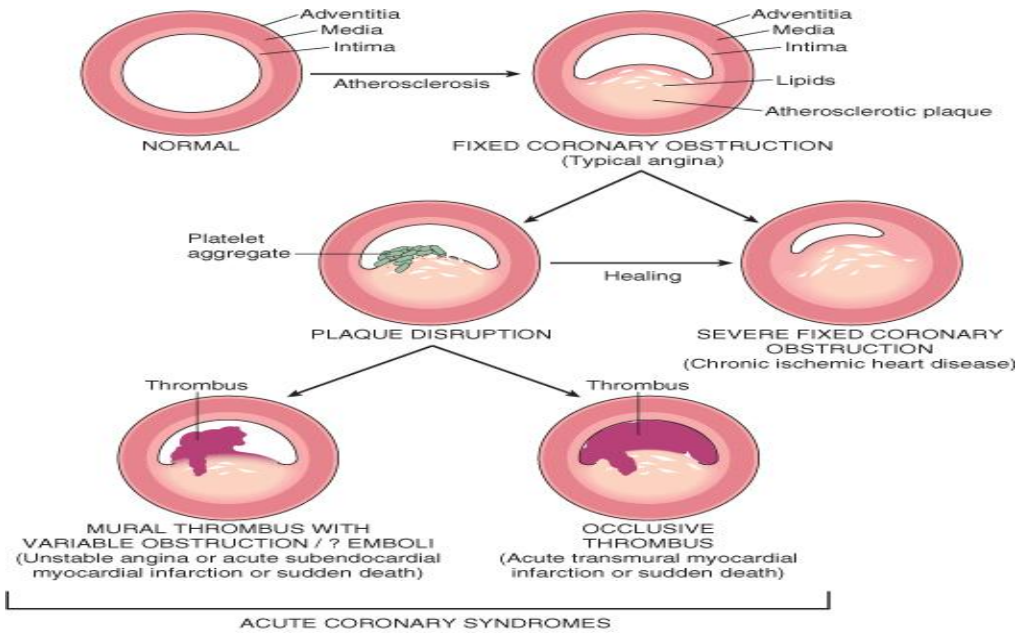
  Manifestation will show up even at rest (because of decreasing in coronary perfusion)

Ischemia can result from increased demand (e.g. increase in heart rate or hypertension)

, or diminished oxygen –carrying capacity (e.g. anemia, CO poisoning)

Pathogenesis

- ↓ coronary perfusion relative to myocardial demand
- Role of Acute Plaque Change
  - **(Erosion/ulceration, Hemorrhage into the atheroma, Rupture/fissuring, Thrombosis)**
- **Role of Inflammation**
  - **T cell, Macrophages, CRP**
- **Role of Coronary Thrombus**
  - **The most dreaded complication**
- **Role of Vasoconstriction (VC)**
  - **Platelet & Endothelial factors, VC substances**



Ischemic Heart Disease

- **Angina Pectoris**
  - **Chest discomfort = prolonged, recurrent, different qualities.** Can radiate down the left arm or to the left jaw *(referred pain)*
  - **Cause = transient myocardial ischemia(seconds to minutes),** Due to inadequate perfusion
  - **Patterns**

Stable = 75% vessel block, transient (<15 minutes), aggravated by exertion, relived by rest & Nitroglycerin (VD). Fixed history is found in "typical angina"

Fixed History is like when a person must rest after every 20 steps he goes up on stairs.

Unstable = 90% vessel block or Acute plaque change (superimposed thrombus), prolonged (>15 min.), not relived by rest, VD, Pre-infarction Angina. It is a complication of atherosclerosis due to rupture of the plaque followed by thrombosis.

Prinzmetal OR variant = coronary spasm, episodic, Typical EKG change – ST elevation, Relived by VD but not rest

Why do we use Nitroglycerin in this situation?

It will cause vasodilatation; blood will be a lot in peripheral vessels and poor in heart (which will make the heart relax)

Ischemic Heart Disease Myocardial infarction

- **MI=** Also called Heart attack
- **Incidence =** disease of old
  - elderly (45% in 65 yrs. old)
  - young (10% in 40yrs. Old),
- **Sex = M**ale > Female
- **Ethnic =** same in African & American
- **Risk factors**
  - Major modifiable- SMOKING,DM, HTN(hypertension) Hypercholesterolemia
  - **HRT for Postmenopausal females – will not protect the heart**

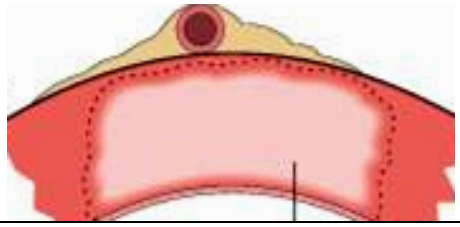
Male affected by MI more than female because Estrogen protects the heart but at menopause they become equal to get the disease

And HRT (hormone replaced therapy) will not protect the heart

- **The severity or duration of ischemia is enough to cause cardiac muscle death**
- **Typically results from acute thromboses that follow plaque disruption**

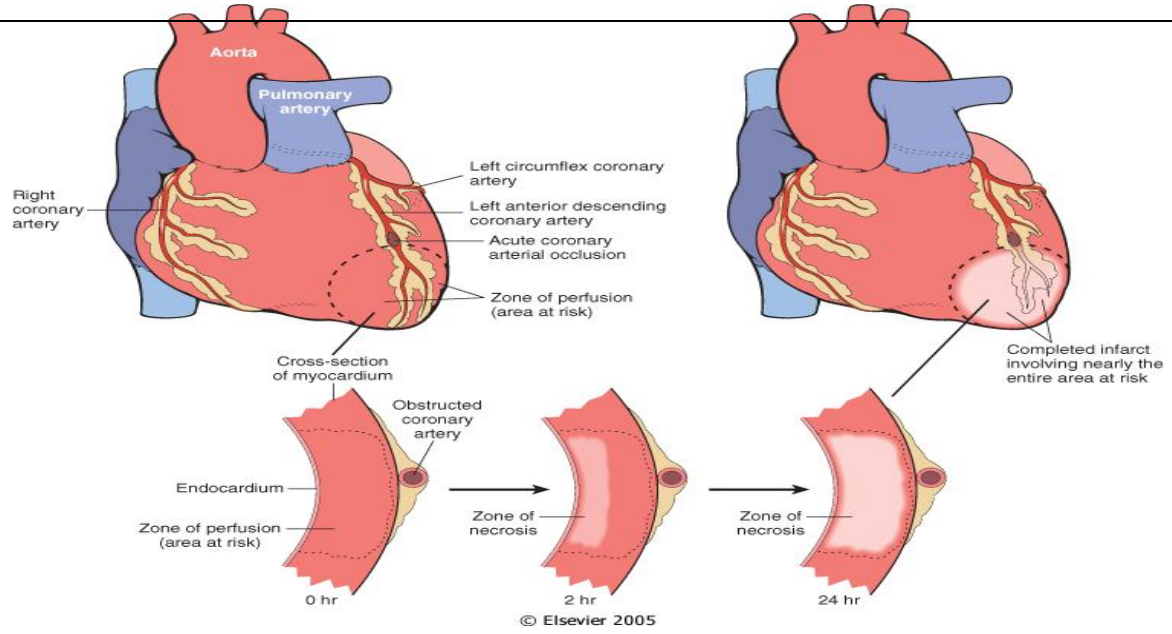
Very Important: The difference between angina and MI is that in angina there is **no** death of tissue.

MI - Types

Transmural	**Sub-endocardial**
• **Full thickness** • **Superimposed thrombus in atherosclerosis** 	• **Inner 1/3 to half of ventricular wall** • **Decreased circulating blood volume (shock, Hypotension, Lysed thrombus)** **Lysed thrombus=broken down to restore blood supply**

MI (myocardial infarction)

- **Pathogenesis**
  - **Coronary vessel occlusion**
    - **Atherosclerosis with thrombus = MC cause (90% cases)**
    - **Others = vasospasm (10%)**
  - **Most important mechanism = dynamic changes in the plaque (rather than plaque size)**
  - **Plaque disruption→ PLTS(platelet) aggregation→ thrombus and Vasoconstriction (happens in minutes)**
  - **Irreversible changes = after 30 minutes of ischemia**
  - **Mechanism of cell death = necrosis (Coagulative)**



Progression of myocardial necrosis after coronary artery occlusion. Necrosis begins in a small zone of the myocardium beneath the endocardial surface in the center of the ischemic zone. The area that depends on the occluded vessel for perfusion is the "at risk" myocardium (*shaded*).

- **The left anterior descending artery** supplies blood to the bulk of the anterior left ventricular wall, while **the left circumflex artery** provides blood to the left atrium and the posterior and lateral walls of the left ventricle.
- **The right coronary artery** provides blood mainly to the right atria and right ventricles.
- Nearly **50%** of all myocardial infarctions involve **the left anterior descending artery** that supplies blood to the main pumping mass of the left ventricle.

The next most common site for myocardial infarction is the right coronary artery, followed by the left circumflex.

MI -Morphology

Light microscopy

First 12 hours after MI – no change

Up to 3 days = Coagulative necrosis, neutrophils

1-2 weeks = Granulation tissue

≥ 3 weeks = fine scar

≥ 2 months = dense scar

Summarized as "Fibrosis"

EM – membrane disruption and mitochondrial densities

Special stain = TTC (Triphenyl Tetrazolium chloride),

Detects and stains Mahogany brown with Lactate dehydrogenase

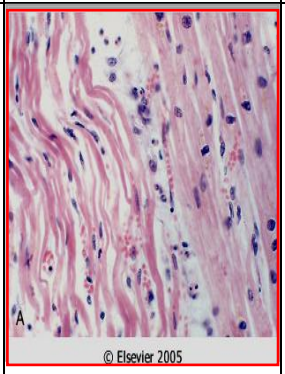
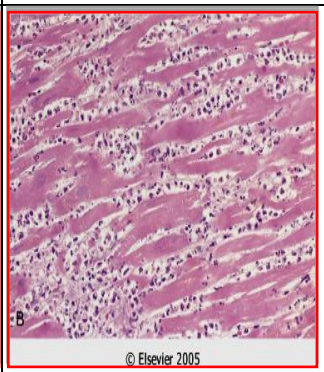
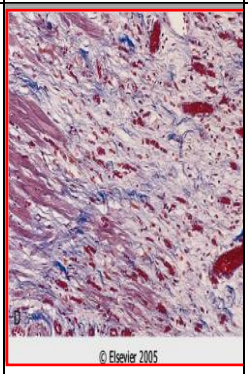
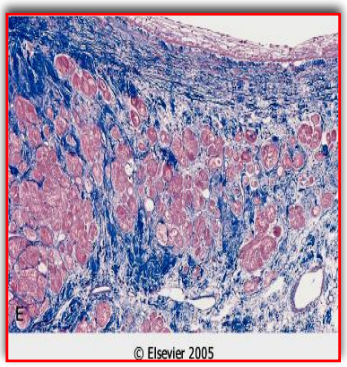
Unstained area = infarction

Mahogany brown = viable

White, glistening= scar

Most common and nonspecific change in ischemia = sub-endocardial myocyte vacuolization

MI- Microscopic features

Time	One-day-old infarct	Up to 3 days duration	1 -2 weeks	>3 weeks
Morphology				
	Wavy fiber (**coagulative necrosis**)	**Neutrophilic infiltrate**	**Granulation tissue**	**Scar**

Ischemia to myocardium

- **It leads to loss of function within minutes and causes necrosis after 20 to 40 minutes**
- For approximately 30 minutes after the onset of even the most severe ischemia, myocardial injury is potentially reversible.
- Thereafter, progressive loss of viability occurs that is complete by 6 to 12 hours.
- The benefits of reperfusion are greatest when it is achieved early, and are progressively lost when reperfusion is delayed
- **MI –Reperfusion**

- **Mechanisms**
  - **Intrinsic**
  - **Extrinsic =**

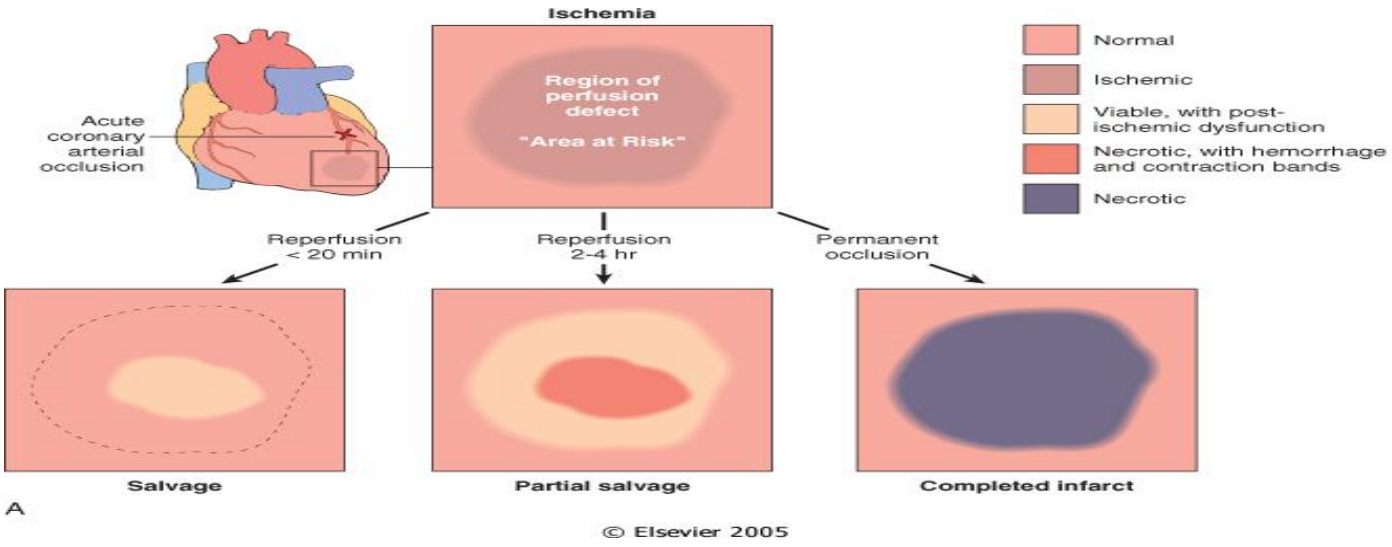
Thrombolytic drugs = < 1hr. After onset of MI

After one hour you cannot give him thrombolytic drugs (no benefit)

PTCA/CABG = > 1hr. After onset of MI

Both of them are kind of surgeries

- **Target** = **clot lysis and restoration of blood flow**



- **Post- reperfusion changes**

Contraction bands = hyper contracting myocytes,

Stunned myocardium = transient, protective dysfunction

Reperfusion damage = mostly apoptosis by free radicals

Ischemic Heart Disease

- MI = Clinical
- **Silent MI** = DM (diabetes mellitus) , Elderly, Cardiac transplantation recipients

  DM patient had usually silent MI because the neuro- defect
- **Typical features** = Rapid, weak pulse and sweating profusely (diaphoretic), Dyspnea, chest pain

  Lab=
  - **Diagnostic**
    - **Best markers = Troponins (T & I), both sensitive and cardio – specific**
    - **Next best – CK-MB**

    Other markers: Lactate dehydrogenase Myoglobin
  - **Predictive**

    CRP- >3mg/l – highest risk

Ischemic Heart Disease ECG

- Changes such as:
  - Q waves (indicating transmural infarcts)
  - ST-segment abnormalities
  - T-wave inversion
- Arrhythmias

Ischemic Heart Disease Laboratory evaluation

- TnI and TnT are not normally detectable in the circulation
- After acute MI both troponins:
  - Become detectable after 2 to 4 hours
  - Peak at 48 hours
  - Their levels remain elevated for 7 to 10 days

Ischemic Heart Disease Laboratory evaluation

- CK-MB is the second best marker

- CK-MB activity:
  - Begins to rise within 2 to 4 hours of MI
  - Peaks at 24 to 48 hours
  - Returns to normal within approximately 72 hours
  - Although cardiac troponin and CK-MB are equally sensitive at early stages of an MI, persistence of elevated troponin levels for approximately 10 days allows the diagnosis of an acute MI long after CK-MB levels have returned to normal

MI –Complications

- In 75% of Patients with MI
- Poor prognosis in = elderly, females, DM, old case of MI, Anterior wall infarct – worst, posterior – worse, Inferior wall – best
  - 1. Arrhythmia = Ventr. Fibrillation –arrhythmia lead to sudden death in MI patients, before they reach hospital.
  - 2. Pump failure – LVF, cariogenic shock, if >LV wall infarcts, lead to death (70% of hospitalized MI patients*)*
  - 3.Ventricular rupture = Free or lateral LV wall – MC site, later cause false aneurysm,
  - 4.True aneurysm = rupture is very rare
  - 5.Pericarditis = Dressler's syndrome (Late MI complication)
- = an autoimmune disorder that may occur several days to several months after acute coronary infarction, characterized by fever, pericarditis, pleurisy, pleural effusions, and joint pain
  - **6.Recurrence**

Ischemic Heart Disease

Chronic IHD = also called ischemic cardiomyopathy (Randomly distributed death of tissue in long duration)

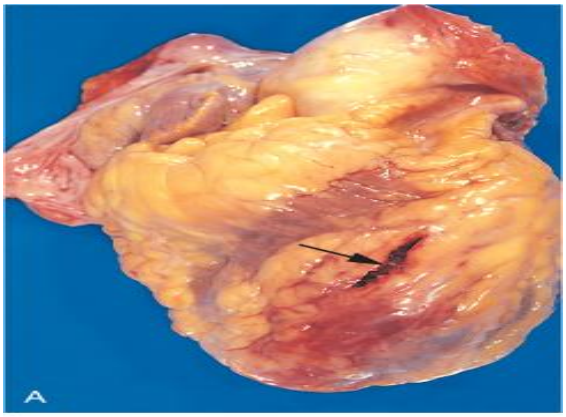
Progressive heart failure due to ischemic injury, either from: prior infarction(s) (most common)

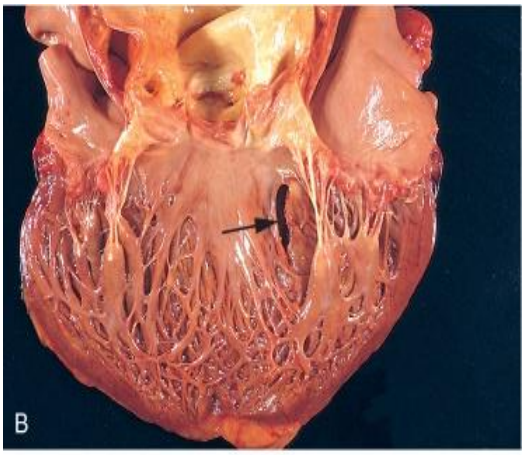
Chronic low-grade ischemia

Cause =compromised ventricular function

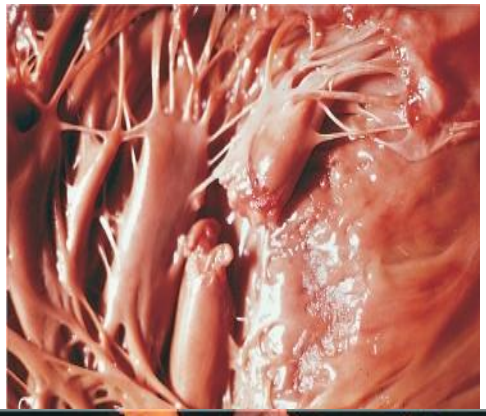
Morphology =vacuoles, Myocyte Hypertrophy

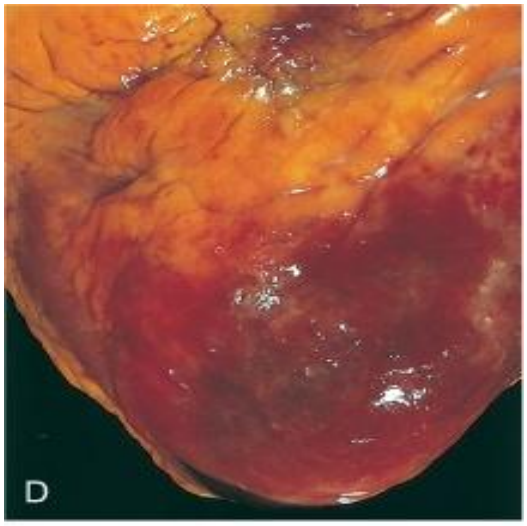
Diagnosis= by exclusion

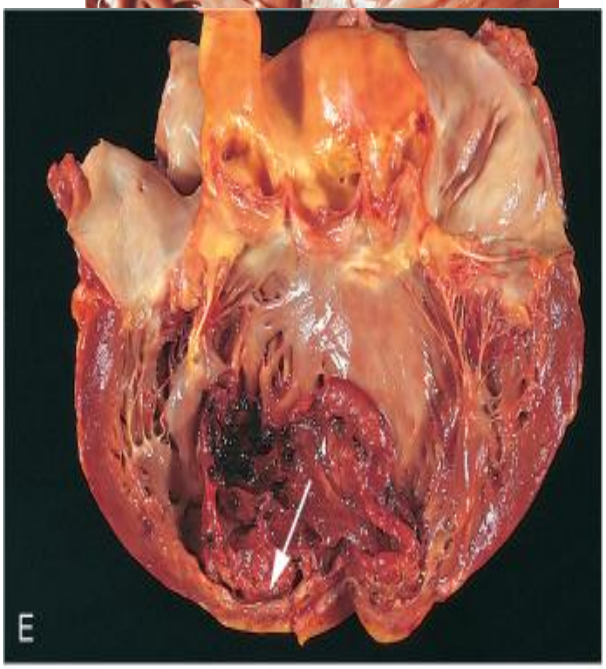




Cardiac rupture syndromes: **A,** Anterior myocardial rupture in an acute infarct *(arrow).* **B,** Rupture of the ventricular septum *(arrow)*. **C,** Complete rupture of a necrotic papillary muscle.







D: Fibrinous pericarditis, showing a dark, roughened epicardial surface overlying an acute infarct.

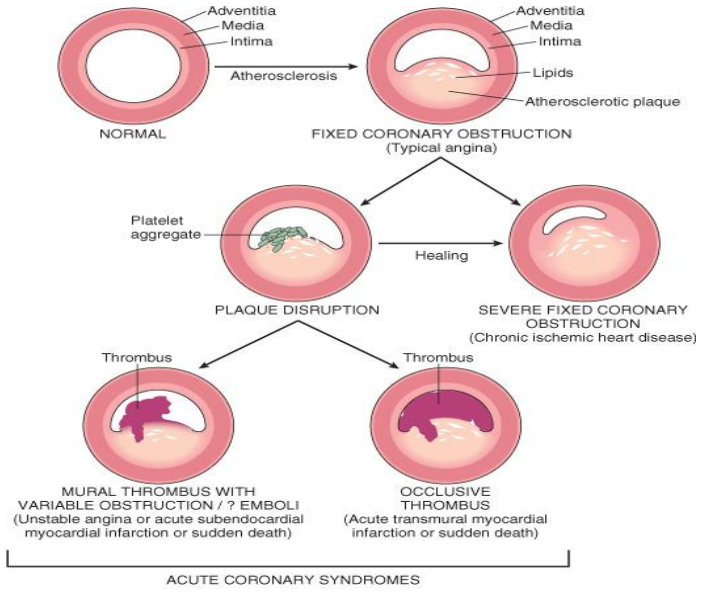
Ischemic Heart Disease *Sudden cardiac death*

- Unexpected death from cardiac causes either without symptoms or within 1 to 24 hours of symptom onset (different authors use different time points)
- Results from a fatal arrhythmia, most commonly in patients with severe coronary artery disease

Ischemic Heart Disease *Acute coronary syndrome*

- is applied to three catastrophic manifestations of IHD:
  - Unstable angina
  - Acute MI
  - Sudden cardiac death

They share common patho-physiologic basis in coronary atherosclerotic plaque disruption and associated intra-luminal platelet-fibrin thrombus formation



Frequently initiated by an unpredictable and abrupt conversion of stable atherosclerotic plaque to unstable plaque followed by thrombosis.

Summary

Ischemic Heart Disease

The vast majority of ischemic heart disease is due to coronary artery atherosclerosis, with less frequent contributions of vasospasm, vasculitis, or embolism. Cardiac ischemia represents a mismatch in coronary supply and myocardial demand, and presents as different, albeit overlapping, syndromes:

Angina pectoris is chest pain due to inadequate perfusion and is typically due to atherosclerotic disease with ≥75% fixed stenosis (so-called critical stenosis).*Unstable angina* results from a small fissure or rupture of atherosclerotic plaque triggering platelet aggregation, vasoconstriction, and formation of a mural thrombus that may not be occlusive. *Acute myocardial infarction* typically results from acute thromboses that follow plaque disruption. *Sudden cardiac death* results from a fatal arrhythmia, most commonly in patients with severe coronary artery disease. *Chronic ischemic heart disease* is progressive heart failure due to ischemic injury, either from prior infarction(s) or chronic low-grade ischemia.

Ischemia to myocardium rapidly (minutes) leads to loss of function and causes necrosis after 20 to 40 minutes. The diagnosis of MI is based on symptoms, electrocardiographic changes, and measurement of serum CK-MB and troponins. Gross and histologic changes of infarction require hours to days to develop. Complications of infarction include rupture of ventricle, free wall, septum, or papillary muscle; aneurysm formation; mural thrombus; arrhythmia; pericarditis; and CHF. (from Robbins)

Questions

What are the four most important treatable risk factors for atherosclerosis?
Smoking, hypertension, diabetes mellitus, hypercholesterolemia.

At what time after infarction are patients at the greatest risk for rupture of an acute MI?
During the first four to seven days.

After first 12 hours of myocardial infarction what is the morphology that we are supposed to see under microscope?

No change in cardiac tissue.

A 53-year-old man present with recurrent chest pain that has gotten progressively worse over the last several weeks. He says that approximately a year ago the pain would occasionally occurs when he was mowing his yard but now the pain sometimes occurs while he is sitting in a chair night reading a book. The pain, which is localized over the sternum, lasts much longer now than it did a few months ago. What type of angina does this individual have at present?

A. Prinzmetal angina.
B. Stable angina.
C. Unstable angina.

Answer:

C

Prinzmetal angina (atypical angina) is characterized clinically by chest pain that occurs at rest rather with exercise. Which of the following is the most likely cause of this type of angina?

A. Atherosclerosis of a coronary artery.
B. Embolism of a coronary artery.
C. Dissection of a coronary artery.
D. Vasospasm of a coronary artery.

Answer:

E