CORONARY CIRCULATION
Normal coronary blood flow

- The resting coronary blood flow = 225 ml/min
- In strenuous exercise = increase three to four folds.
Phasic changes in coronary blood flow
Epicardial Vs. subendocardial blood flow
Control of coronary blood flow

- Metabolic regulation
- Nervous control
Blood flow through coronary system is regulated almost entirely by local arterial vasodilatation in response to cardiac muscle need for nutrients.
- **Oxygen demand.**
- **Vasodilator substances:**
  - Adenosine.
  - Potassium ions.
  - Hydrogen ions.
  - Carbon dioxide.
  - Bradykinin.
  - Prostaglandins.
**Nervous control**

- **Direct effect:**
  - Direct action of Ach and Nepi on coronary vessels.

- Vascular dilatation
  - $\beta$ receptors

- Sympathetic transmitter

- Vascular constriction
  - $\alpha$ receptors
Indirect effect:

- Symp stimulation $\rightarrow$ ↑ HR & contractility $\rightarrow$ ↑ Rate of metabolism.
- ↑ activity $\rightarrow$ local blood flow regulatory mechanisms $\rightarrow$ blood flow increases.
Ischemic heart disease
Ischemia:

- Lack of oxygen due to inadequate perfusion of the myocardium, which causes imbalance between oxygen supply and demand.
Etiology of ischemic heart disease

Myocardial Oxygen Supply and Demand

- O2 Supply
- O2 Demand

- coronary blood flow
- oxygen availability

- heart rate
- contractility
- preload
- afterload
Coronary atherosclerosis

The most common cause of myocardial ischemia.
Epicardial coronary arteries are the major site.

Major risk factors:
- Increase in LDL.
- Decrease in HDL.
- Cigarette smoking.
- Hypertension.
- DM.
NORMAL FUNCTION OF VASCULAR ENDOTHELIUM

- Local control of vascular tone.
- Maintenance of an anticoagulant surface.
- Defense against inflammatory cells.

LOSS OF THESE DEFENSES

- Inappropriate constriction.
- Luminal clot formation.
- Abnormal interactions with blood monocytes & platelets.
Acute coronary occlusion

• Thrombosis.
• Embolism.

• Local spasm:
  • Direct irritation of the smooth muscle.
  • Nervous reflexes.
Location of the obstruction

- Influence the quantity of myocardial ischemia.
- Determines the severity of the clinical manifestations.
Collateral circulation

- With sudden occlusion.
- With gradual developing atherosclerosis.
Disturbances of myocardial functions:
- Mechanical function.
- Biochemical function.
- Cell membrane function.
- Electrical function.
1) Mechanical function:

- Failure of normal muscle contraction & relaxation.
- Ischemia of large portions of ventricle: left ventricular failure.
- Regional disturbances:
  - Systolic stretch.
Effect of ischemia

2) Biochemical function:

- Fatty acid can’t be oxidized.
- Glucose is broken down to lactate.
- Reduced intracellular pH and ATP stores.
3) **Cell membrane function:**
   - Leakage of potassium and uptake of sodium by myocytes.

4) **Electrical function:**
   - **ECG changes:**
     - Repolarization abnormalities.
     - Transient ST segment depression.
   - **Electrical instability:**
     - Ventricular tachycardia and fibrillation.
Ischemic heart disease

Stable angina (chronic artery disease)

Acute coronary syndrome:
• Unstable angina.
• Acute MI.
Stable angina...

- An effort-related chest discomfort.

- **Characteristics:**
  - Heaviness.
  - Pressure.
  - Squeezing.
  - Smothering.
  - Choking pain.
Stable angina...

- **Causes:**
  - CAD.
  - Other heart diseases:
    - Aortic valve disease.
    - Hypertrophic cardiomyopathy.
Stable angina...

**History:**
- A man > 50 years.
- A woman > 60 years.
- Pain with physical & emotional exertion.
- Last to 5-10 min.
Stable angina...

- Radiating pain to the left shoulder, both arms, back, interscapular region, root of the neck, jaw and teeth.
Stable angina...

- **physical examination:**
  - Atherosclerotic disease at other sites.
  - Important risk factors:
    - Hyperlipidemia
    - DM.
  - Left ventricular dysfunction.
  - Conditions that may exacerbate angina:
    - Anemia.
    - Thyroid disease.
Laboratory examination:

- Urine analysis (DM and renal disease).
- Full blood count.
- Measurements of:
  - lipids,
  - Glucose.
  - Createnine.
  - Hematocrite.
  - Thyroid function test.
Stable angina...

- Other investigations:
  - Resting ECG: most important baseline investigation.
  - Stress testing.
J point as the zero reference potential of the electrocardiograms for leads I and II. Also, the method for plotting the axis of the injury potential is shown by the lowermost panel.
Stable angina...

- **Other investigations:**
  - Coronary arteriography.
Stable angina...

- **Management:**
  - A careful assessment.
  - Identification and control of aggravating conditions.
  - Identifications of high risk pts.
  - Application of treatment to improve life expectancy.
Stable angina...

**Drug therapy:**
- nitrates.
- β-adrenergic blockers.
- Calcium antagonist.
- Antiplatelet drugs.
Unstable angina...

- Angina pectoris that is rapidly worsening.

- **Characteristics:**
  - Occurs at rest, usually lasting >10 min.
  - Sever and of new onset.
  - Crescendo pattern.
Unstable angina...

**Causes:**

- Shares common pathophysiological mechanisms with acute MI.
- Plaque rapture or erosion.
- Dynamic obstruction (coronary spasm).
- Rapidly advancing coronary atherosclerosis.
Unstable angina...

- **History:**
  - History of chronic stable angina.
  - May present as new phenomena.
  - Chest pain (substernal region, radiating to the neck, left shoulder and left arm).
Unstable angina...

- **Physical examination:**
  - Diaphoresis.
  - Pale cool skin.
  - Sinus tachycardia.
  - 3\textsuperscript{rd} or 4\textsuperscript{th} heart sound.

- **Biochemical markers:**
  - Troponin I & T.
  - CK.
Unstable angina...

- **ECG changes:**
  - 12 lead ECG is mandatory.
  - ST elevation or depression.
Unstable angina...

**Management:**
- Urgent admission to hospital.
- Bed rest.
- Antiplatelet.
- β-blockers (atenolol).
- IV or buccal nitrates.
- Revascularization.
**STABLE ANGINA**

- Fixed stenosis.
- Demand-led ischemia.
- Predictable.
  - Exercise tolerance test.

**UNSTABLE ANGINA**

- Dynamic stenosis.
- Supply-led ischemia.
- Unpredictable.
  - Clinical features.
  - ECG changes.
  - Biochemical markers.
Myocardial infarction

- Occurs when there are zero flow or so little flow that it can’t sustain cardiac muscle function.
- Occlusive thrombus in a coronary artery.
Myocardial infarction

- **Clinical features:**
  - Pain (sever, last longer).
  - Breathlessness.
  - Vomiting.
  - Collapse.
  - Syncope.
Myocardial infarction

- **Investigations:**
  - **ECG:**
    - Partial thickness infarction $\rightarrow$ ST/T wave changes.
    - Transmural infarction $\rightarrow$ ST elevation and Q waves.
  - **Biochemical markers.**
  - **Chest radiography.**
  - **Cardiac US.**
Management:

- Immediate access to hospital.
- High-flow oxygen.
- ECG monitoring.
- I.V analgesia and antiemetic.
- Detect and manage acute complications:
  - Arrhythmia.
  - Ischemia.
  - Heart failure.
Complications of infarction:
- Arrhythmia.
- Ischemia.
- Acute circulatory failure.
- Pericarditis.
- Embolism.
Causes of death in MI:
- Decreased CO.
- Damming of blood in the pulmonary or systemic veins.
- Fibrillation.
- Rupture of the heart.
Surgical treatment of coronary disease

- Aortic-coronary bypass surgery.
- Coronary angioplasty.
Aortic coronary bypass surgery
Coronary angioplasty