HAEMODYNAMIC DISTURBANCES

Part I
Types of haemodynamic disturbances

Disturbances in the volume of the circulating blood
1) hyperemia (arterial and venous)
2) ischemia
3) plasmorrhage, hemorrhage (bleeding)
4) shock

Disturbances of obstructive nature
1) stasis
2) thrombosis
3) embolism
4) infarction
5) ischaemia
• Hyperemia
  – Active process

• Congestion
  – Passive process
  – Acute or Chronic

Lung
  • acute
  • chronic

Liver
  • acute
  • chronic
Arterial (or active) hyperemia (plethora)

**Arterial hyperemia** - increase of blood flow into organ or tissue due to the increased inflow of arterial blood

1. Physiological and pathological
2. General and local
Symptoms of arterial hyperemia

- redness (*rubor*) of the skin and mucous
- widening of the small arteries, arterioles, veins, and capillaries
- increased number of visible vessels and their pulsation in the affected area
- increase of local body temperature
- increased pressure in arterioles, capillaries, veins
- acceleration of blood flow
- increased metabolism
- increased organ function
Causes of arterial hyperemia

• mental factors
• biological factors
• chemical factors
• mechanical factors
• increased function of an organ
Physiological arterial hyperemia

- blushing i.e. flushing of the skin of face in response to emotions,
- muscular exercise,
- menopausal flush.
Causes of general pathological arterial hyperemia

• **Increase of plasma volume**
  – Ex.: intensive fluid therapy

• **Erythrocytosis**
  – Primary
    - erythremia, polycythemia
  – Secondary
    - hypoxic conditions: lung disease, high altitudes, etc.
Types of local pathological arterial hyperemia

- angioneurotic (neuroparalytic)
  - due to innervation lesion
- collateral
  - due to the obstruction of blood flow through the main artery
- hyperemia after ischemia
  - after elimination of the ischemia factor (tumor, ligature, etc.), squeezing the artery
- vacatous (*vacuus* – empty)
  - due to the decrease in barometric pressure.
- inflammatory
- due to arteio-venous fistula
  - due to gunshot
Venous (passive, congestive) hyperemia – increased plethora of organ or tissue due to reduced outflow of blood through the veins, the inflow remains unchanged or a few reduced.

1. Acute and chronic
2. General and local
Symptoms of venous hyperemia

- dark red color of skin and mucous membranes (cyanosis)
- increased tissue or organ volume
- lowering of local temperature
- increased pressure in the veins and capillaries
- slowing of blood flow, pendulum motion
- stasis
- edema
- diapedesic hemorrhage
- dystrophy and necrosis
- sclerosis and atrophy
Causes of venous hyperemia

• General
  – heart failure
    • acute HF ➔ acute general venous hyperemia
    • chronic HF ➔ chronic general venous hyperemia

• Local
  • thrombosis of veins
  • external compression of veins by tumors

• Left ventricle HF ➔ venous hyperemia in pulmonary circulation
• Right ventricle HF ➔ venous hyperemia in systemic circulation
Heart failure (cardiac decompensation, insufficiency)

- **Heart failure** is a pathological condition caused by the inability of heart to provide adequate blood flow to organs and tissues.
Causes of cardiovascular insufficiency

- CHD (coronary heart disease)
- heart disease
- hypertensive state
- myocarditis
- cardiomyopathy
- diseases of malnutrition
- endocrine and metabolic lesions
Causes of acute cardiovascular insufficiency

Left ventricle HF
• myocardial infarction
• acute myocarditis
• infectious disease with severe intoxication
• cardiac tamponade

Right ventricle HF
• thromboembolism in major branches of the pulmonary artery
• decompensation of left ventricle HF
Morphology of acute cardiovascular insufficiency

Acute venous hyperemia

• Acute left ventricle HF
  – pulmonary edema
• Acute right ventricle
  – acute venous hyperemia of greater circulation
Causes of chronic left ventricular heart failure

- cardio sclerosis (chronic ischemic heard disease)
- congenital heart defects
- rheumatic heart defects
- arterial hypertension
- cardiomyopathy
- chronic myocarditis
- states, accompanied by increased cardiac output (severe anemia, etc.)
Morphology of chronic left ventricular heart failure

• Chronic venous lungs hyperemia with the development of brown induration
Morphogenesis of brown induration of lungs

Chronic venous hyperemia, pulmonary hypertension, tissue hypoxia

Adaptive vascular reorganization

Vascular sclerosis, failure of adaptation

Amplification of tissue hypoxia

Increased vascular permeability

Diapedesic hemorrhages - hemosiderosis

Fibroblasts activation - pneumosclerosis
Causes of chronic right ventricular heart failure

• chronic inflammatory lung diseases with pulmonary hypertension
• decompensation of chronic left ventricular heart failure
• some congenital heart defects: atrial septal defect, pulmonary stenosis, tricuspid disease
RIGHT SIDED HEART FAILURE
(Cor Pulmonale)

- Fatigue
- ↑ Peripheral Venous Pressure
- Ascites
- Enlarged Liver & Spleen

- May be secondary to chronic pulmonary problems
- Distended Jugular Veins
- Anorexia & Complaints of GI Distress
- Weight Gain
- Dependent Edema
Morphology of chronic right ventricular heart failure

- Nutmeg liver
- Cyanotic induration of skin, kidney and spleen
- Edema of the lower limb
- Ascites
Morphogenesis of congestive liver fibrosis

Chronic venous stasis, hypoxia

Proliferation of fibroblasts and adipocytes

Sinusoidal capillarization

Progressive liver fibrosis
Right side HF +
Left side HF
Hemorrhage (bleeding)

Hemorrhage is an extravasation of blood from vessel or heart cavities into the extravascular space or body cavity

• External (GI, pulmonary, etc.) and internal hemorrhage

• Primary and secondary
Morphological types of hemorrhage

1. Hematoma - "blood tumor" - hemorrhage with formation of a cavity filled with blood.
2. Hemorrhagic infiltration - impregnation of tissue with blood preserving tissue components.
3. Bruise - planar hemorrhage (skin, mucous membranes)
4. Petechia and ecchymosis - punctate hemorrhage.
5. Rapidly developed massive hemorrhages - apoplexy.
• **hemarthrosis** - hemorrhage into the joint cavity
• **hemopericardium** - accumulation of blood in pericardial cavity, also called cardiac tamponade
• **hemothorax** - accumulation of blood in pleural cavity
• **hemoperitoneum** - accumulation of blood in abdominal cavity
• **hemocephaly** - accumulation of blood in ventricles brain
• **Hematocele** - hemorrhage under testis tunica
• **Hematuria** - blood in urine
• **Cephalhaematoma** - hemorrhage under periostea of skull
• **Hematorrhachis** - spinal cord hemorrhage
• **Purpura** – tissue multiple hemorrhages
• **epistaxis** – nose hemorrhage
• **haemotemesis** – vomiting with blood
• **maelena** – fecal blood
• **metrorrhagia** – uterine cavity hemorrhage (not during menstruation)
• **haemoptoe** ("coughing up blood") - respiratory tract hemorrhage
Mechanisms of haemorrhage

• Rupture
  (*haemorrhagia per rhexin*).

• Vessels wall corrosion
  (*haemorrhagia per diabrosin*).

• Through the intact wall
  (*haemorrhagia per diapedesis*).
Causes of haemorrhagia per rhexit

• injury
• inflammation
• necrosis
• aneurysm
• vascular malformations
• sclerosis
• hyalinosis
Causes of haemorrhagia per diabrosin

- tumor
- necrosis
- inflammation
- ectopic pregnancy
Causes of haemorrhagia per diapedesis

- hypoxia
- intoxication
- hemorrhagic diathesis
Hemorrhagic diathesis

- hemorrhage tendency states

• Angiopathy
  – hereditary hemorrhagic telangiectasia Rendu-Osler disease,
  – scurvy,
  – Schonlein-Henoch disease

• Thrombocytopathies
  – thrombocytopenia,
  – hemolytic uremic syndrome,
  – von Willebrand disease

• Coagulopathy
  – hemophilia,
  – disseminated intravascular coagulation syndrome (DIC)
The outcomes of hemorrhage

- Resorption with formation of blood pigments.
- Cyst formation after resorption of blood.
- Encapsulation and germination connective tissue of hematoma (organization).
- Accession infection and suppuration.
Local anemia

- Local anemia (syn.: ischemia) - decreased tissue blood filling, organ, body part as a result of inadequate blood flow.
Ischemia attributes

- Skin blanching or disappearance of previously visible small blood vessels
- Decreased organ or tissue volume
- Lowering of local temperature
- Slowing of blood flow
- Fall of blood pressure below the obstruction
- Sensory disturbances, pain
- Malfunction
- Degeneration, necrosis
- Atrophy of the parenchymal cells and stromal sclerosis
Types of local anemia

1. angiospastic (spasm of artery)
2. obstructive (obstruction by thrombus)
3. compression (external compression by tumor or scar)
4. anemia as a result of blood redistribution
Outcomes of ischemia

• Acute
  – reverse to normal state
  – infarction, acute organ failure

• Chronic
  – Fibrosis, cirrhosis, chronic organ failure