

Circulatory Disorders

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Thrombosis

Definition: Formation of a compact mass composed of elements of circulating blood inside a vessel or heart cavity **during life**. This compact mass called thrombus.

Causes of Thrombosis

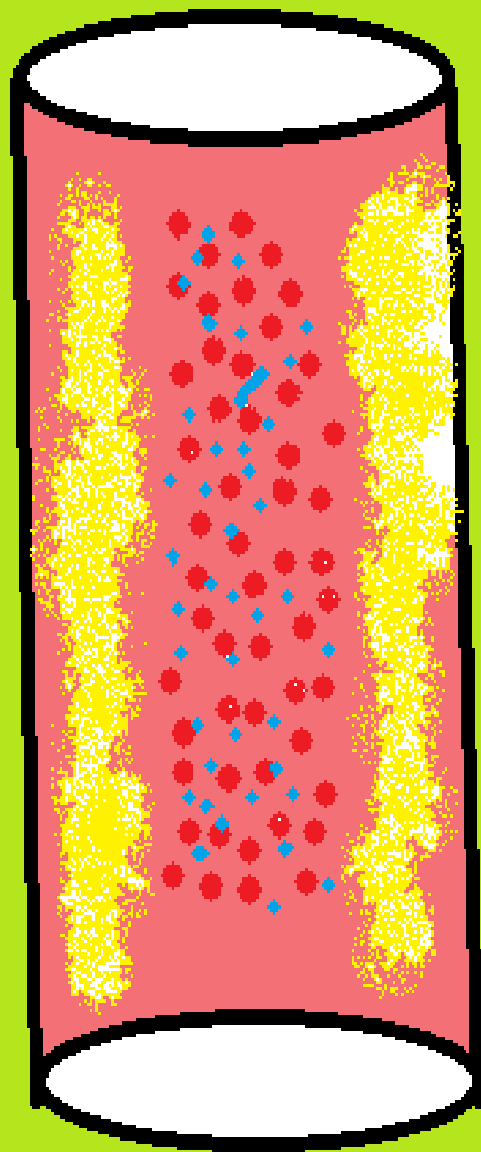
1- Damage to vascular endothelium: by trauma, pressure, ligation, canulation, inflammation or atheroma.

2- Slowing of blood stream: in normal blood stream, the blood cells occupy central part and plasma in peripheral part. In stasis, platelets cross plasmatic zone and come in contact to vascular endothelium. Stasis occurs in the following conditions:

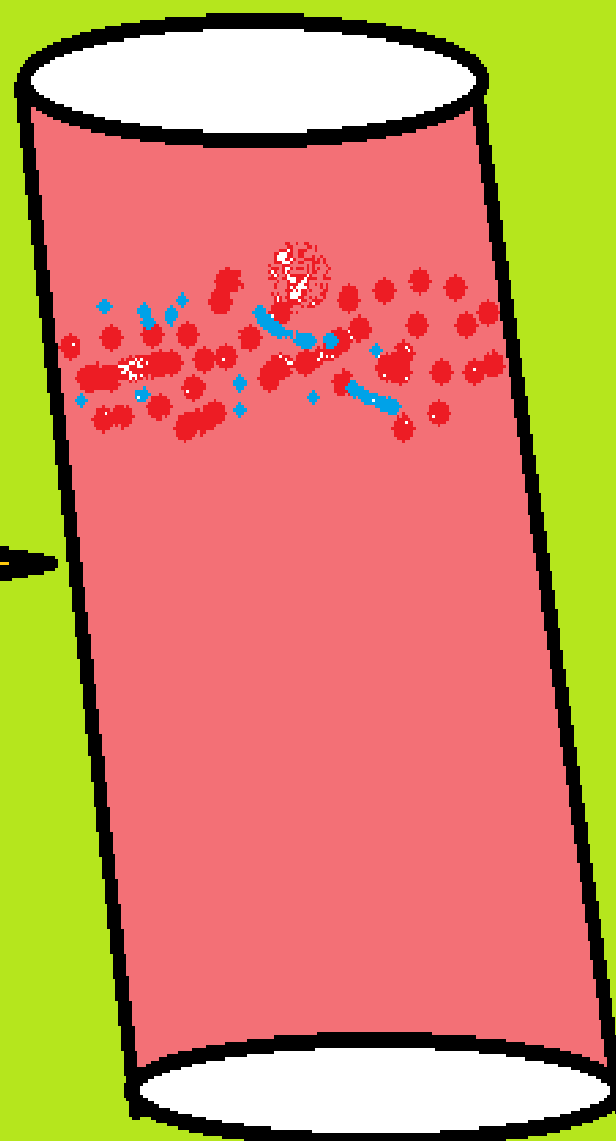
- In heart failure especially in veins of the leg.
- In the auricles of the heart in association with valvular diseases.
- In aneurysmal sacs, varicose veins and in the portal vein secondary to liver cirrhosis.
- In tissues showing acute inflammation.

**Damage to the
endothelial lining**





Stasis



3- Disordered blood stream:

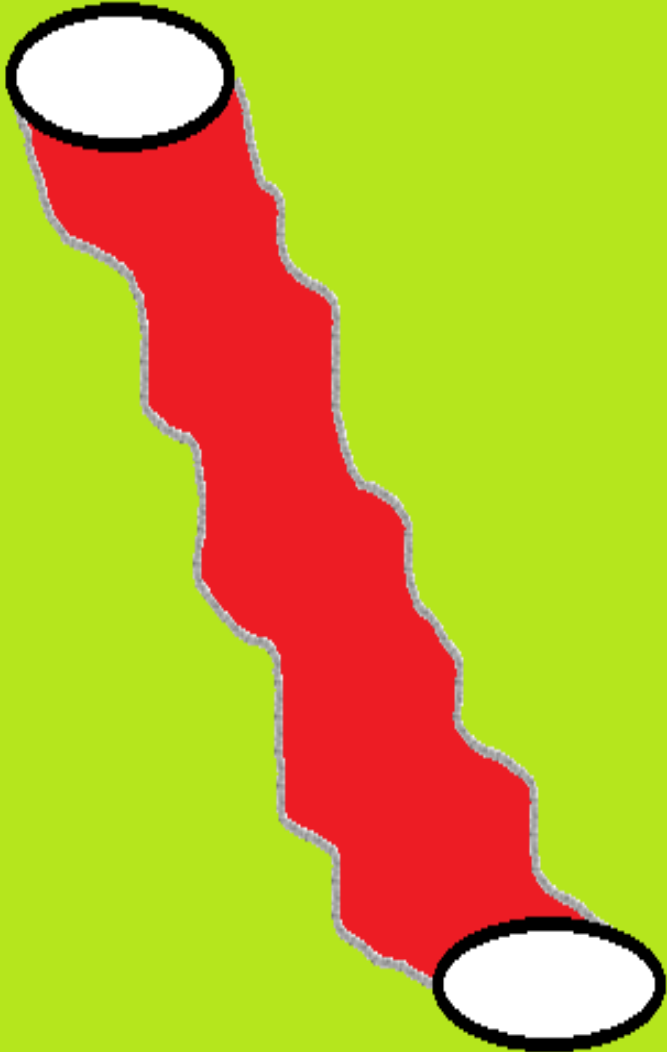
Distortion of the vascular lumen as in aneurysm, atheroma, varicose veins and compression of the vessel wall from outside. All these allow platelets to come in contact with the vascular endothelium and initiate thrombosis.

4- Change in blood composition:

After operations, platelets increase in number and become more sticky. They agglutinate in small masses and adhere to vascular endothelium. Their lysis release thromboplastin which starts thrombosis.

- Fibrinogen also increase in pregnancy and lobar pneumonia.
- RBCs increase in polycythaemia causing increase blood viscosity and stasis.
- WBCs increase in leukaemia.
- Plasma decrease in dehydration.

Varicose Vein



Atheroma

Formation of Thrombus and Types of Thrombi

1) Pale thrombus (platelet thrombus): the initial thrombus is composed only of platelets. The platelets deposit on the site of endothelial damage. They adhere to the exposed subendothelial collagen by help of von Willebrand factor (factor VIII). This factor produced by endothelial cells and acts as a bridge between platelet surface receptors and collagen. The adherent platelets release ADP and serotonin which promote further adhesion and aggregation of platelets forming a small white amorphous mass. Such platelet is fragile and can be washed easily by blood stream except if stasis occurs.

2) Mixed thrombus: stasis allows clotting factors to accumulate in the area. Thromboplastin released from the platelets and damaged tissues promote fibrin formation which deposit on the primary platelet thrombus. Next the deposited fibrin encourage further platelet accumulation. The platelets deposit as laminae at a right angle to the blood stream. Between these laminae, there is complete blood stasis and fibrin is deposited entangling the red and white blood cells. the formed thrombus is a mixed one and it is composed of both platelet masses and blood clots.

3) Propagating thrombus: if the formed thrombus occludes a vein completely, proximal to occlusion the blood will be stagnant and it clots. The clot is soft, red and fixed to the original thrombus but not to the vascular wall. When this propagating thrombus reached a level at which a tributary or a branch joins the affected vein. The thrombus occurs again as blood will be once more in motion. The process repeat and the propagating thrombus extends in the direction of the heart.

Classification of Thrombi

I- According to color:

- Pale thrombus: formed mainly of platelets and fibrin. It is small, greyish-white, firm and adherent to intima as cardiac vegetations.
- Red thrombus: formed mainly of RBCs and fibrin. It is dark-red, soft and loosely attached to the vessel wall. It is very rare.
- Mixed thrombus: most thrombi has red and pale components.

II- According to presence or absence of bacteria:

- Infected thrombus: the thrombus contains bacteria. If the bacteria are pyogenic, the thrombus is called septic thrombus.
- Non-infected thrombus (aseptic): it doesn't contain bacteria.

Sites of Thrombus Formation

I- Thrombosis in Veins

It is the most common due to slow blood flow and thin venous walls. Two types occur;

1- Thrombophlebitis: thrombosis is initiated by inflammation of the venous wall. Thrombophlebitis can be classified into two categories:

- Septic Thrombophlebitis: occurs in veins draining septic lesion as appendicular vein in case of acute appendicitis and pelvic veins in case of puerperal sepsis.
- Aseptic Thrombophlebitis: inflammation is caused by factors other than bacteria as trauma and radiations. A small fixed aseptic thrombus occurs.

2- Phlebothrombosis: thrombosis caused by factors other than inflammation.

- As what occurs in veins of the feet and calf in chronic cardiac patients due to stasis of blood and compression of calf muscles against bed mattress.
- Thrombosis of varicose veins due to stasis.
- Thrombosis in femoral and pelvic veins after labor or abdominal operations due to increase number of platelets after operations and mild inflammation at site of operation.

II- Thrombosis of the Arteritis

less common than venous thrombosis due to rapid blood flow and thick elastic arterial wall which resist injury. Arterial thrombosis cause ischaemia.

- Thrombosis may occur in arteries affected by atherosclerosis, polyarteritis nodosa thromboangitis obliterance due to roughness of the intima.
- It also may occur in aneurysms due to stasis, disordered blood stream and rough intima.

III- Thrombosis of the Heart

More common in the left side, the following types may occur;

- **Mural thrombi:** it occurs over infarcts, commonly on the endocardial surface of the left ventricle near the apex.
- **Vegetations:** pale thrombi over the valves in rheumatic and bacterial endocarditis.
- **Auricular thrombi:** develop in atrial appendages in heart failure due to stasis. Rarely the thrombus detach and remains in the dilated atrial cavity and is called **ball thrombus**.

IV- Thrombosis of Capillaries

Generally are rare, but may occur in acute inflammation and sever cold.

Fate of Thrombi

1) Septic thrombus: it is fragmented by proteolytic enzymes into septic emboli causing pyaemic abscess.

2) Aseptic thrombus: its elements disintegrate and form a pale red structureless mass. If the mass is small it dissolves by fibrinolysis. If it is large; it undergoes one of the followings:

- Organization: the thrombus get invaded by capillaries and fibroblasts from the vascular wall and change to fibrous mass. This cause permanent vascular occlusion.
- Organization with subsequent canalization: some of the invaded capillaries dilate and allow passage of blood through the thrombus. Or the fibrous thrombus shrinks from the vascular wall leaving a space which is then get lined by endothelium.
- Dystrophic calcification: may occur giving a phlebolith.
- Detachment: forming aseptic emboli causing infarction.
- Propagating thrombus.

Clot

Definition: A mass of blood elements formed in stagnant blood. The clot is soft, dark red with a glistening smooth surface. The clot is not adherent to the vessel wall.

Post mortem clots: they occur in cardiac chambers after death. They are of two types:

- Red or Current Jelly clot: occurs with rapid blood clotting. It is formed of fibrin network entangling red and white blood cells.
- Yellow or chicken fat clot: occurs with slow blood clotting. This allows sedimentation of RBCs in the dependent part, while plasma, fibrin and white cells are above. Slow clotting occurs with anticoagulant therapy or with deficient coagulation factors as in haemophilia.

Thrombus	Clot
Occurs in circulating blood	Occurs in stagnant blood
Firmly attached	Loosely attached
Friable and dry	Soft and moist
Pale, red, mixed	Red and yellow
Shows lines of Zhan	No lines of Zhan

Emolism

Definition: impaction of an embolus in a narrow vessel.

Embolus: an insoluble solid, liquid or gaseous mass circulating in the blood stream.

Sites of embolism:

- Systemic arteries.
- Pulmonary arteries.
- Intrahepatic branches of portal vein.

Types of Emboli

- Detached thrombi and vegetations.
- Tumor emboli.
- Parasitic emboli as bilharzial ova.
- Air emboli.
- Fat emboli.
- Clumps of bacteria amniotic fluid emboli.

Course of Emboli of Thrombotic Origin

- ❑ An embolus from systemic vein or right side of the heart passes through the pulmonary artery and impacted in the lung.
- ❑ An embolus from left side of the heart or aorta get impacted in systemic artery (cerebral, renal, splenic,...).
- ❑ An embolus from portal radicals become impacted in intrahepatic branches of portal vein.
- ❑ An embolus from systemic veins can by pass the lung through a patent foramen ovale or interventricular septal defect to be arrested in a systemic artery, called paradoxical embolism. Another explanation for paradoxical embolism is that the embolus is so small that it can pass through the pulmonary capillaries.

Effect of emboli of thrombotic origin: It depends on

- Size of the impacted embolus.
- Nature of the embolus; septic or aseptic.
 - **Aseptic embolus:** cause transient ischaemia if the collateral circulation is good and infarction if poor collaterals.
 - **Septic embolus:** produces pyaemic abscesses at site of its impaction.
- State of collateral circulation.

Air Emboli

results from:

- Injury to large veins in the neck. Air is sucked by negative pressure in the thorax.
- Faulty technique in doing artificial pneumothorax and in blood transfusion.
- In criminal abortion, air is sucked into uterine veins.

Fat Embolism

Resulting from:

- Bone fracture and crush limb injury.
- Cutaneous burns.
- Inflammation of fatty tissues.
- Severe fatty change in the liver.

Amniotic Fluid Embolism

It is rare, resulting from strong uterine contractions cause tears in fetal membranes. Amniotic fluid pushed in opened veins. Such condition cause fatal pulmonary embolism to the mother.

Effect of Pulmonary Embolism

- ❖ **Big embolus:** occlude the pulmonary artery or one of its main branches. Serotonin released in big amounts from the platelets of the embolus cause bilateral vasoconstriction of the pulmonary arterioles and death within seconds to minutes due to acute right side heart failure.
- ❖ **Medium sized embolus:**
 - If the lung is healthy; no effect as the lung has double blood supply (pulmonary and bronchial).
 - If the lung has chronic venous congestion; infarction will occur.
- ❖ **Small sized emboli:** usually no effect.

Ischaemia

Definition: decrease blood supply to an organ or part of an organ below its needs due to occlusion of its artery. Ischaemia may be sudden or gradual.

I- Sudden ischaemia (acute ischaemia):

Sudden complete arterial occlusion due to

- Thrombosis or embolism.
- Surgical ligation of an artery.
- Twisting of a pedicle of a movable organ as intestinal loop.
- Arterial spasm as in ergot poisoning.

Effects:

- ❖ Sudden complete occlusion of end arteries or arteries with inefficient collaterals cause infarction or gangrene.
- ❖ Sudden occlusion of arteries with efficient collaterals usually doesn't cause tissue damage.

Gradual ischaemia (chronic ischaemia):

It is gradual incomplete arterial occlusion due to

- ❖ Atherosclerosis.
- ❖ Pressure on an artery by enlarged lymph node or tumor.

Effects:

The gradual occlusion gives a chance for collateral circulation to open up.

- **With inefficient collaterals;** cellular degeneration, atrophy and replacement by fibrosis occur.
- **With efficient collaterals;** no tissue damage occur

Haemorrhage

Definition: Haemorrhage means escape of blood outside blood vessels or cardiac chambers.

Causes of Haemorrhage:

- *Traumatic causes.*
- *Spontaneous haemorrhage as in:*
 - ✓ Diseased vascular walls as atherosclerosis or aneurysms.
 - ✓ Inflammatory injury to vascular wall.
 - ✓ Destruction of the vascular wall by tuberculosis, malignancy or peptic ulcer.
 - ✓ Increased intravascular tension as in hypertension and chronic venous congestion.
 - ✓ Haemorrhagic blood diseases.
 - ✓ Vitamin deficiencies as vit. K,C.

Types of haemorrhage

External Haemorrhage: It is escape of blood outside the body

- ◆ Epistaxis: bleeding from the nose.
- ◆ Haemoptesis: coughing of blood. The source of the blood is lung or bronchi. The blood is red, frothy and alkaline.
- ◆ Haematemesis: vomiting of blood. The source of blood is the esophagus, stomach and duodenum. Blood is digested, brown in color, acidic and mixed with food particles.
- ◆ Melena: dark digested blood in the stool. The source of blood is the esophagus, stomach and duodenum.
- ◆ Haematuria: blood in the urine.
- ◆ Menorrhagia: excessive or prolonged menstrual bleeding.
- ◆ Metrorrhagia: irregular uterine bleeding not related to menstrual cycle.
- ◆ Haemorrhage from the skin.

Internal Haemorrhage: escape of blood inside body cavities (serous sacs).

- ◆ Haemothorax: Haemorrhage in the pleura.
- ◆ Haemopericardium: Haemorrhage in the pericardial sac.
- ◆ Haemoperitoneum: Haemorrhage in the peritoneal cavity.
- ◆ Haematocele: Haemorrhage in the tunica vaginalis.
- ◆ Haemoarthrosis: Haemorrhage in the joint cavity.

Interstitial Haemorrhage: escape of blood into the interstitial tissue spaces.

- ◆ Petechial Haemorrhage: small amount of blood of capillary origin.
- ◆ Ecchymosis: moderate amount of blood.
- ◆ Haematoma: large amount of blood causing swelling.

Effect of Haemorrhage

- I. Small amounts and once:** no effect.
- II. Small amounts but repeatedly as in piles, peptic ulcers** causing microcytic hypochromic anaemia.
- III. Moderate amount (up to 750 cc):** is compensated by
 - ✓ Immediate fall in blood pressure.
 - ✓ Decrease hydrostatic pressure inside the vessels allow withdrawal of tissue fluids to blood vessels.
 - ✓ Increased secretion of adrenaline help in increasing blood pressure.
 - ✓ Reflex vasoconstriction of blood vessels in skin, muscles and splanchnic area to maintain adequate blood supply to vital organs.
 - ✓ Proteins are added from the liver.
 - ✓ WBCs and RBCs are added from bone marrow.
- IV. Massive amount:** cause haemorrhagic shock and death.

Shock

- ❑ **Definition:** shock means a widespread hypoperfusion of cells and tissues occurring due to ineffective circulating blood volume.
- ❑ **Clinically:** the patient is confused, restless with rapid, weak pulse, low blood pressure and shallow respiration. The skin is pale, cold and covered by sweat. The amount of urine is decreased (oliguria).

Types of shock

- ❑ Hypovolemic shock: acute reduction of blood volume as in severe haemorrhage, severe burns or severe acute dehydration.
- ❑ Cardiogenic shock: marked reduction of cardiac output due to occlusion of coronary artery, rupture cusps of a valve, major arrhythmias or cardiac tamponade.
- ❑ Septic (endotoxic) shock: caused by severe bacterial infection.
- ❑ Rare types as neurogenic and anaphylactic shock.

Thank You

