



Lecture 5:

Thromboembolism

OBJECTIVES

- At the end of this lectures, the student should:
- Understand the basic pathology of thrombogenesis .
- Pathological aspects of thrombogenesis: vessel wall abnormality, vascular stasis or turbulent flow and increased blood coagulability.
- the risk factors for development of deep vein thrombosis
- Causes of embolism formation.
- Know the types of embolus than can occur and the pathology of pulmonary embolism.
- Brief description of other forms of emboli like: fat embolism, air embolism, atherosclerotic plaque embolism, amniotic fluid embolism, nitrogen embolism and infective endocarditis

THROMBUS

Is a solid mass of intravascular coagulation of blood and it often causes significant interruption to blood flow.

Pathogenesis

Virchow triad predispose to thrombus formation:

- (1) Endothelial cell injury
- (2) Stasis or turbulence of blood flow
- (3) Blood hypercoagulability

Components of the hemostatic process

1. **Platelets:** participate in endothelial repair through the contribution of PDGF (platelet derived growth factor)
2. **Endothelial cells** injury.
3. **Coagulation Cascade** is a major contributor to thrombosis.*

*Fibrin from coagulation cascade is a constituent of the thrombus

Hypercoaguable States

Hypercoagulable states can be

1. Primary/Genetic : e.g. mutation in factor V gene or prothrombin gene (factor II), anti-thrombin III deficiency, protein C or S deficiencies, or fibrinolysis defects.

2. Secondary/acquired states: they can be high risk or low risk

a) High risk for thrombosis

- Prolonged bed rest or immobilization*
- Myocardial infarction, Atrial fibrillation
- Tissue damage (surgery, fracture, burns)*
- Tumors *
- Prosthetic cardiac valves
- Disseminated intravascular coagulation*
- Heparin-induced thrombocytopenia
- Antiphospholipid antibody syndrome (lupus anticoagulant syndrome)

b) Lower risk for thrombosis

- Cardiomyopathy
- Hyperestrogenic states (pregnancy)*
- Sick cell anemia
- Nephrotic syndrome
- Oral contraceptive use
- Smoking.

*All of these with congestive heart failure and advanced age are the risk factors for deep venous thrombosis .

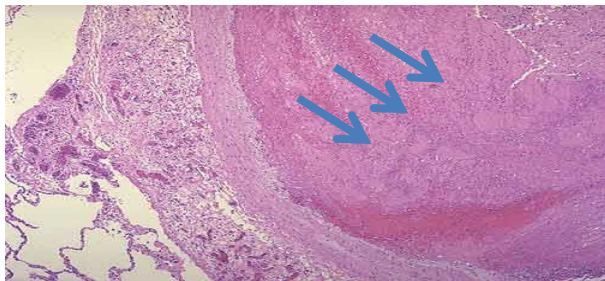
*characterized by widespread thrombosis within the microcirculation ,resulting from the consumption of platelets and coagulation factors.

Morphology of thrombus

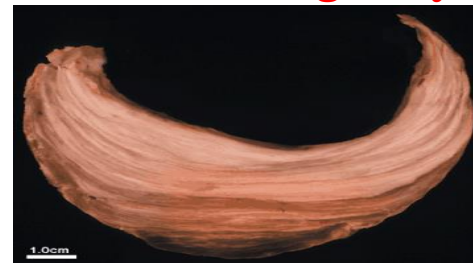
- Thrombi may develop anywhere in the cardiovascular system.
- They vary in size and shape, depending on the site of origin.
- A thrombus is made up of
 - ❑ Fibrin
 - ❑ Platelets
 - ❑ Red blood cell.
 - ❑ Inflammatory cells
- Often have grossly and microscopically apparent laminations called **lines of Zahn***
- Such laminations signify that a thrombus has formed in flowing blood, **indicate Antemortem thrombosis**

*Pale platelet and fibrin deposits alternating with darker red cell-rich layers.

Lines of Zahn microscopy



Lines of Zahn grossly



Types of thrombosis :

1- Arterial thrombi

- It is **frequently occlusive**, the most common sites in decreasing order of frequency are:
 1. Coronary.
 2. Cerebral.
 3. Femoral .
- It is usually superimposed on an **atherosclerotic plaque** and are firmly adherent to the **injured arterial wall**.
- Arterial or cardiac thrombi usually **begin at sites of turbulence or endothelial injury**.
- Arterial thrombi are **gray-white and friable**.
- thrombi grow in a retrograde direction from the point of attachment (i.e. **toward the heart**).

2- Venous thrombosis (Phlebothrombosis)

- It is **almost invariably occlusive**, venous thrombi characteristically occur at sites of **stasis**
- Because these thrombi form in the sluggish venous circulation, **they tend to contain more enmeshed red cells** (and relatively few platelets) and are therefore known as **red or stasis thrombi**.
- The veins of the **lower extremities** are most commonly involved (90% of cases)
- Venous thrombi extend in the direction of blood flow (i.e. **toward the heart**).

3- Postmortem clots

- At autopsy, postmortem clots may be confused for venous thrombi.
- **red cells have settled by gravity** and a **yellow “chicken fat” upper portion**.

4- Deep venous thrombosis & Thrombophlebitis (DVT)

- In the larger leg veins - at or above the knee (e.g. popliteal, femoral, and iliac veins)
- DVT may give rise to pulmonary embolism with resultant pulmonary infarct.
- Often **associated with inflammation**
- such thrombi more often embolize to the lungs and give rise to pulmonary infarction
- can cause local **pain** and **edema**.
- DVTs are **asymptomatic** in approximately 50% of affected individuals and are recognized only in retrospect after embolization

5- Thrombi on Heart Valves (vegetations)

Happen in:

- 1) **infective endocarditis**.
- 2) Sterile vegetations develop on **nonbacterial thrombotic endocarditis**.
- 3) Less commonly, noninfective, verrucous (Libman-Sacks) endocarditis attributable to elevated levels of circulating immune complexes may occur in patients with **systemic lupus erythematosus**

6- mural thrombi

is arterial thrombi arise in heart chambers or in the aortic lumen..

Fate of Thrombus

- Resolution
- Propagation
- Embolism
- Organization and recanalization*
- Organization and incorporation into the wall.

* Means new blood vessels formation (**Angiogenesis**)

EMBOLISM

- **Definition:** is a detached intravascular **solid, liquid, or gaseous mass** that is carried by the blood to a site distant from its point of origin.
- **thromboembolism:** dislodged thrombus
- resulting in partial or complete vascular occlusion leading to ischemic necrosis of distal tissue (**infarction**).

Pulmonary Thromboembolism

- the embolus get lodged in the pulmonary vasculature.
- In more than 95% of cases, venous emboli originate from deep leg vein thrombi
 - **Depending on the size of the embolus, it may:**
 - Occlude the main pulmonary artery
 - **(saddle embolus)** Impact across the bifurcation
 - Pass out into the smaller, branching arterioles
 - **(paradoxical embolism):** Rarely, embolus that passes through an interatrial or interventricular defect to gain access to the systemic circulation
- Most pulmonary emboli are clinically **silent because they are small**.
- **Sudden death, right heart failure (cor pulmonale), or cardiovascular collapse** occurs when more of the pulmonary circulation is obstructed with emboli.
- Embolic obstruction of small end-arteriolar pulmonary branches may result in **infarction**.

Systemic Thromboembolism

- **In arterial circulation.**
- Most (80%) arise from **mural thrombi**.
- The major sites for arteriolar embolization are the **lower extremities** (75%) and the **brain** (10%).

Fat Embolism

- Microscopic fat globules may be found in the circulation after fractures of **long bones** (which have fatty marrow) or, rarely, in soft tissue trauma and burns.
- Fat is released by marrow or adipose tissue injury and enters the circulation through rupture of the blood vessels and act as an embolus.
- **Fat embolism syndrome** is characterized by
 - pulmonary insufficiency
 - neurologic symptoms
 - anaemia
 - thrombocytopenia.

Amniotic Embolism

- A grave but fortunately **uncommon**. Complication of labour and the immediate **postpartum period**
- caused by infusion of amniotic fluid or fetal tissue into the maternal circulation via a tear in the placental membranes or rupture of uterine veins.
- Characterized by **(sudden severe dyspnea, cyanosis, and hypotensive shock, followed by seizures and coma)**.
- **If the patient survives the initial crisis, the patient may develop:**
- **Pulmonary edema and diffuse alveolar damage.**
- **Disseminated Intravascular Coagulation (DIC), due to release of thrombogenic substances from amniotic fluid.**

Air Embolism

- Gas bubbles within the circulation can obstruct vascular flow (and cause distal ischemic injury) acting as thrombotic masses. **Bubbles may coalesce to form frothy masses sufficiently large to occlude major vessels.**
- An excess of **100 Cc*** is required to have a clinical effect.

* Cubic Centimeter

Air Embolism

(Decompression sickness)

- Occurs when individuals are exposed to sudden changes in atmospheric pressure.
e.g. **Scuba and deep-sea divers are at risk**
- Can induce focal ischemia in a number of tissues:
 - Brain and heart
 - Skeletal muscles , causing pain (**the bends**)
 - In the lungs, respiratory distress, (**the chokes**)
- **Treatment:** placing the individual in a compression chamber
- chronic form of decompression sickness is called **caisson disease** in which, persistence of gas emboli in the skeletal system leads to multiple foci of ischemic necrosis; the more common sites are the heads of the femurs, tibia, and humeri.

Questions

1- What is thrombus?

Solid mass of blood constituents which develops in artery or vein

2- Who are the coaguable people?

People who have higher chance to develop thrombosis

3- Why prolonged bed rest or immobilization make the patient hypercoaguable?

Because of blood stasis process

4- How Myocardial infarction and atrial fibrillation cause thrombosis?

By stasis of blood

5- What is the different between thrombus and embolus?

Thrombus is stocked to the wall of a vessel, embolus is mobile

6- Why do the venous thrombus look red?

Contain more enmeshed erythrocytes

Questions

7- How to distinguish between postmortem clot And other clots happened during life?

Postmortem are gelatinous with a dark red dependent portion where red cells have settled, not attached to the underlying wall.

8- Why should we be worried about deep vein thrombosis?

May give rise to pulmonary embolism with resultant pulmonary infarct

9- How the pulmonary embolism goes the arterial circulation?

May pass through an interatrial or interventricular defect

10- What should happen to a person to make the fat enters the blood circulation?

Burns or long bone fractures

MCQs

1) Which of the following is a component of Virchow triad?

- A. Endothelial Injury
- B. Bleeding
- C. Hypotension
- D. Fibrinolysis

2) What happen if the blood gets stagnant?

- A. Thrombus Will Be Formed
- B. Gangrene
- C. Loss Of Sensation
- D. Hemorrhage

3) What substances dissolve fibrin?

- A. Plasmin
- B. Plasminogen
- C. Thrombin
- D. Factor XII

4) Which one of the following have higher risk factor for thrombus formation?

- A. Sickle cell anemia
- B. Nephrotic syndrome
- C. Prolonged bed rest or immobilization
- D. Cardiomyopathy

Answers :

1-A

2-A

3-A

4-C

MCQs

5) Which of the following have lower risk factor for thrombus formation?

- A. Cancer
- B. Tissue Damage
- C. Cardiomyopathy
- D. Prolonged bed rest or immobilization

Answers :

5-C

6-C

7-D

8-C

6) Which of the following is not a common site for venous thrombi?

- A. The Superficial Veins Of The Leg
- B. The Deep Vein Of The Thigh
- C. Cerebral Veins

7) Which of the following is not a predisposing factor for deep vein thrombosis?

- A. Pregnancy
- B. Advanced Age
- C. Bed Rest And Immobilization
- D. Congenital Factor

8) Where does turbulence in the blood flow happen in?

- A. Arteries
- B. Veins
- C. Site Of Division In Either Artery Or Vein
- D. A+B

MCQs

- 9) Where does venous thrombi occur?
- A. Site Of Stasis
 - B. Site Of Turbulence
 - C. All
 - D. Neither
- 10) In which direction does the arterial thrombi grow?
- A. Direction Of The Blood Flow
 - B. Retrograde Direction
 - C. Against The Direction Of The Heart
 - D. None Of Them
- 11) What are the lighter lines in the line of Zahn?
- A. Fibrin And Platelet
 - B. White Blood Cells
 - C. Fat
 - D. RBCs
- 12) What are the red lines in the line of Zahn?
- A. Red Blood Cells
 - B. Lymphocytes
 - C. Neutrophils
- 13) What is the mural thrombi?
- A. Arterial thrombi arise in heart chambers
 - B. Arterial thrombi in the brain
 - C. Venous thrombi in the IVC

Answers

9-A

10-B

11-A

12-A

13-A

MCQs

- 14) Which of the following is a common site for arterial thrombi?
- A. Axillary Artery
 - B. Cerebral Arteries
 - C. Pulmonary Trunk
 - D. Aorta
- 15) What do the arterial thrombi look like?
- A. Red And Friable
 - B. Gray-White And Friable
 - C. Red Taking The Shape Of The Artery
- 16) Which of the following is true about the venous thrombi?
- A. Look Like Gray-White And Friable
 - B. Take The Shape Of The Vein
 - C. Occur Mainly In Cardiac Veins

Answers

14-B

15-B

16-B

Team's members:

Contact us:



Pathology433@gmail.com



[@pathology433](https://twitter.com/pathology433)

- MAHA ALZEHEARY

-ABDULRAHMAN ALTHAQIB

-Areej ismael

- Othman Abid

