Erythrocyte Sedimentation Rate (ESR)

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Second Stage

Introduction

Erythrocyte Sedimentation Rate (ESR) is a common hematological test for nonspecific detection of inflammation that may be caused by infection, some cancers and certain autoimmune diseases.

ESR can be defined as a measurement of the rate at which the RBCs (erythrocytes) settle from the plasma in anti- coagulated blood.

ESR is helpful in diagnosis of two specific inflammatory diseases:

1. Temporal arteritis
2. Polymyalgia rheumatic.

- The ESR test is **easy to perform** and **inexpensive**.

In general, normal range:

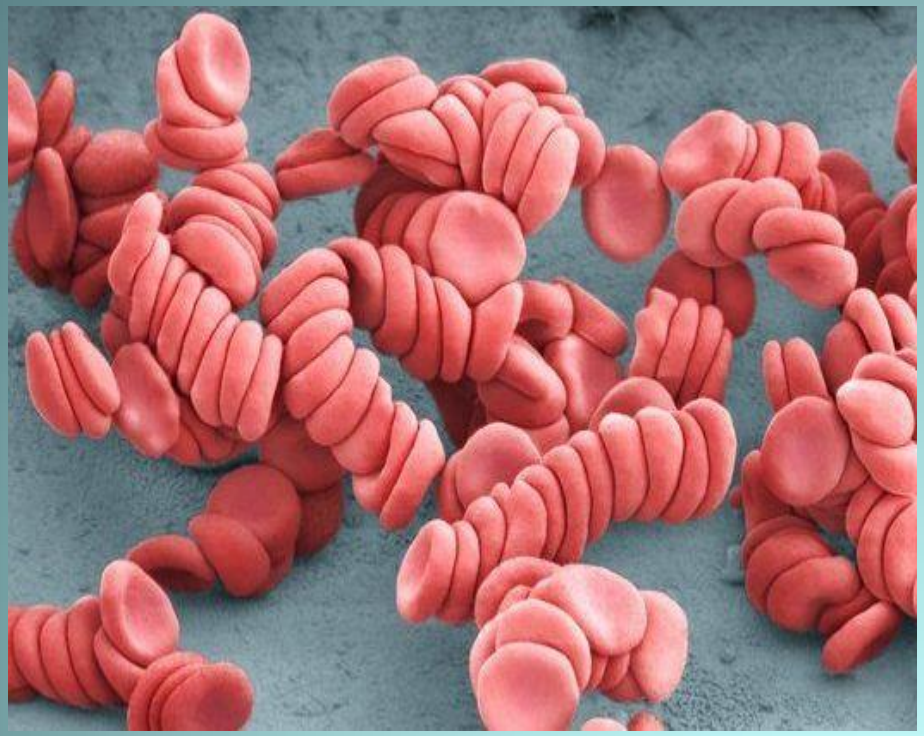
- Males 0-15 mm/hr.
- Females 0-20 mm/hr.
- Children (<10) 0-10 mm/hr.
- Newborns under 2 mm/hr.

Mechanism

- ESR is determined by the interaction between factors that promote (fibrinogen) and factors that resist (negative charge of RBC) sedimentation.
- Normally, RBCs settle down slowly as they don’t form rouleaux. Instead, they gently repel each other due to the negative charge on their surface.
- Rouleaux are stacks of many RBCs that become heavier and settle down faster.
- Plasma proteins, especially **fibrinogen**, adhere to the red cell membranes and neutralize the surface negative charges, promoting cell adherence and rouleaux formation.
- ESR is directly proportional to the weight of the cell aggregates and inversely proportional to the surface area.

This mechanism involves three stages:

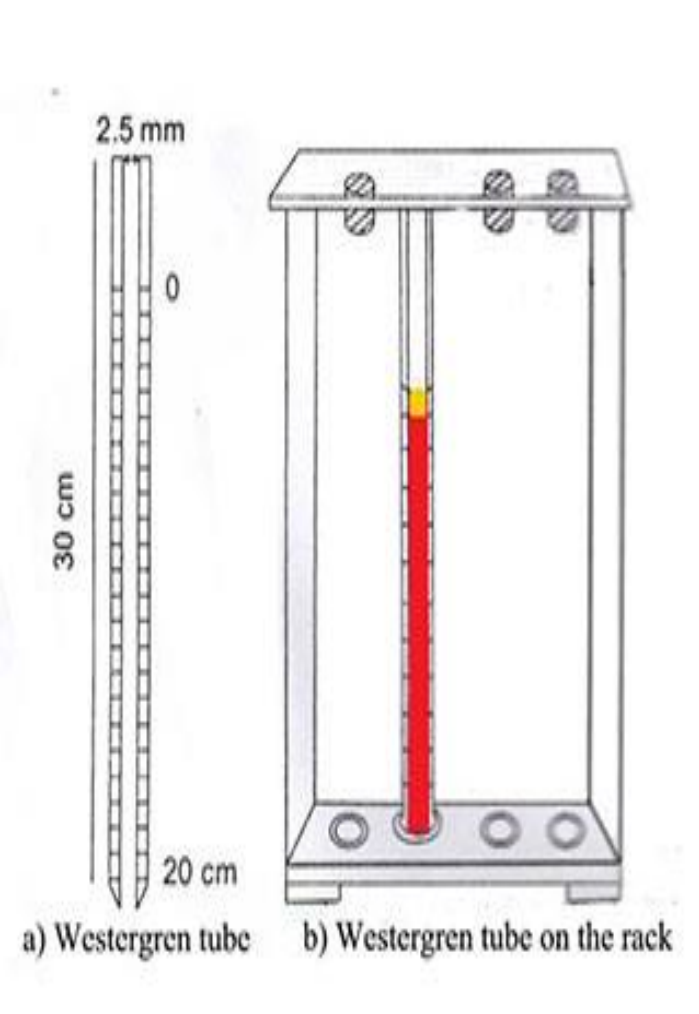
1. **Stage of aggregation**: It is the stage of rouleaux formation/aggregation. It occurs in the first 10-15 min.
2. **Stage of sedimentation**: It is the stage of actual RBCs sedimentation, it occurs at constant rate. This occurs in 30-40 minutes out of 1hr.
3. **Stage of packing**: This is the final stage and is also known as **stationary phase**. In this stage, there is a slower rate of falling during which packing of sedimenting RBCs in column occurs due to overcrowding. It occurs in final 10 minutes in 1 hour.



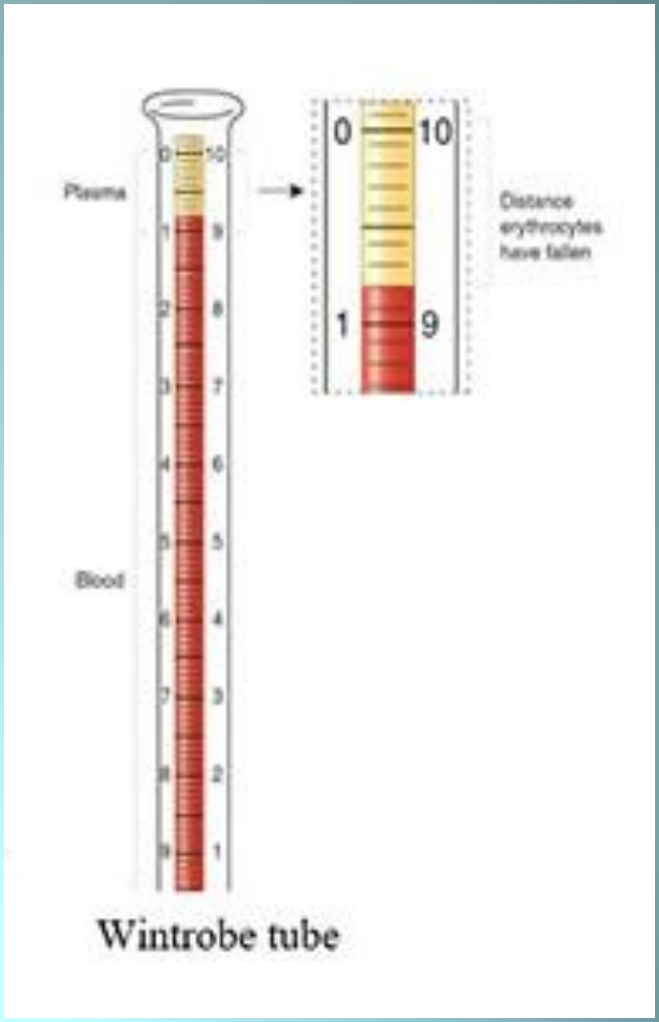
Rouleaux Formation and how it looks like under microscope

Methods of ESR Determination:

a. Westergren Method: widely used method for ESR estimation.



B. Wintrobe Method: also used for ESR determination. Wintrobe tube is smaller than Westergren tube.



Objectives:

a. To knowledge to measure Erythrocyte Sedimentation Rate (ESR).

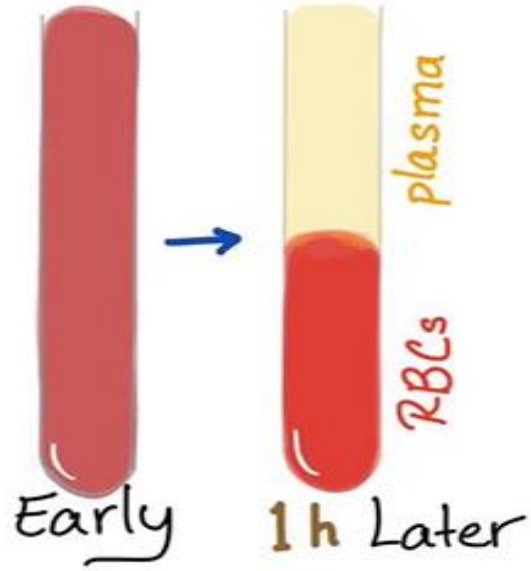
b. To get an idea about the mechanism and principle of ESR.

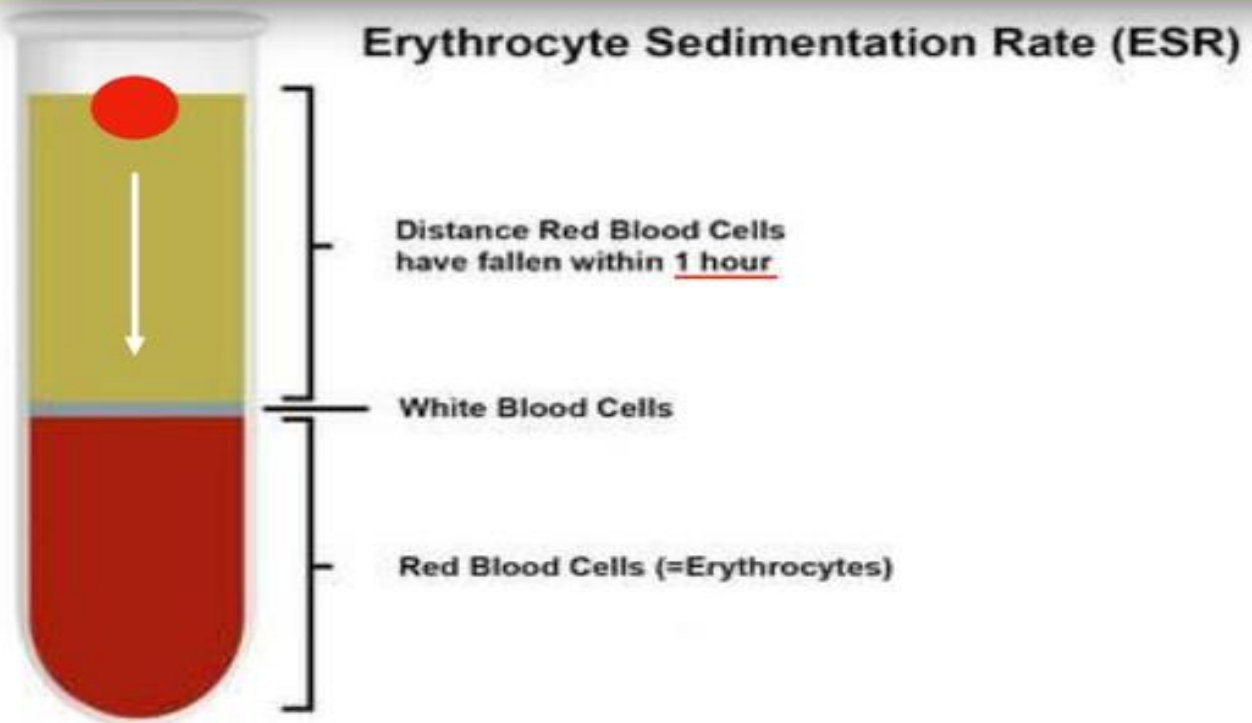
c. To recognize the clinical value of ESR.

ESR fast detector method

1. It is done on a blood sample using a syringe attached to a fine needle to collect a venous blood from the patient.
2. Transfer it to a container of anticoagulant (Sodium citrate).
3. Transfer the tube to its stand in vertical form.
4. Leave the tube undisturbed in this position for 30-60 minute.
5. At the end of which read the mm of clear plasma above the red cells.

ESR


plasma
RBCs
Early
1 h Later


Erythrocyte Sedimentation Rate (ESR)
Distance Red Blood Cells have fallen within 1 hour
White Blood Cells
Red Blood Cells (=Erythrocytes)

Note:

- ✓ Wintrobe method has the same procedure as Westergren method except that at the end of the one hour the tube is centrifuged at 2000-3000 rpm to complete the separation of RBCs which enables us to get the PCV value.
- ✓ Westergren method is more reliable than Wintrobe method and gives accurate result.

ESR increases in:

1- Inflammatory disease such as (arthritis, vasculitis)

2-Infections like (pneumonia, pelvic inflammatory disease, appendicitis, skin and bone infection).

3- Autoimmune disease like (systemic lupus erythematous [SLE], or rheumatoid arthritis)

4- Chronic kidney disease

5- Cancer

6- Old age and Pregnancy (physiological not pathological)

- **A decreased ESR will be present in:**
  - Polycythemia.
  - Congestive heart failure.
  - Hypofibrinogenemia.
  - Red blood cell abnormalities such as sickle cells.
  - Increase albumin level in the blood.

Factors affecting the ESR

1- Effect of plasma proteins: Changes in plasma proteins occur rapidly following tissue injury or in response to inflammation. Increased concentration of fibrinogen and immune-globulins will increase rouleaux formation and hence the rate of sedimentation. Plasma albumin retards sedimentation of RBCs.

2- The RBC count and number: The size and the number of the RBCs also effect on the ESR, the cells which show alteration in the size like Spherocytosis and sickle cells, usually do not exhibit increase rate, unless there is severe anemia. Increased red cells mass, retards the sedimentation rate, e.g. Polycythemia.

3- Technical factors:

a- The tube should be vertical, and not any vibration can reduce the ESR

b- Temperature (18-25 C˚) higher temperature can cause false high results due to the reduction in the plasma viscosity.

4- Pregnancy: lead to High ESR values can .

5- Drugs: like steroids can decrease the ESR values

6- Vitamin A and oral contraceptive can increase ESR values.