

Erythrocyte Sedimentation Rate (ESR, method by Fahraeus and Westergren)

Blood containing anticoagulant agent remains for a relatively long time in a form of suspension, also in *in vitro* conditions. The main factors making RBC dispersed in plasma are negative electrical charges on their surfaces. Opposite to these, positive electrical charges of blood plasma are directed. Thus, each RBC is surrounded in this way by double layer of electrical charges. This so called *Helmholtz double-layer* helps to their mutual repulsion and holds them in the form of suspension. The *suspension stability of the blood* is measured according to its reciprocal value – *sedimentation rate*.

The **Erythrocyte Sedimentation Rate (ESR)** is dependent on various factors, e.g. on size and count of RBC, on quantitative changes of the ratio between the plasma proteins, on concentration of lipids or pH of blood plasma.

Although the result of ESR measurement is non-specific, it is often used in clinics since it indicates severity of the disease and in repetitive investigation it may show dynamics of the pathological changes.

In older literature, 2-5 mm in males and 3-8 mm in females in the first hour of the investigation have been taken as physiological. In the second hour the ERS should not exceed the double amount of the first ESR value (in the 1st hour).

Newly, to take age into account, ESR in males can be calculated as: $ESR = [age \text{ (in years)}] : 2$ and in females as $ESR = [age \text{ (in years)} + 10] / 2$. Thus, as normal ESR <15 mm/hour in males <50 years, ESR <20 mm/hour in males >50 years, ESR <20 mm/hour in females <50 years and ESR <30 mm/hour in females >50 years have been found. In newborns values up to 2 mm/hour and in adolescence between 3-13 mm/hour have been considered for physiological.

Increased ESR may be found also in physiological conditions, e.g. in pregnancy, in menstruation and in older people. In pathological conditions, higher ESR may be found in infectious inflammation (mostly of bacterial origin, e.g. bacterial endocarditis, pneumonia, acute glomerulonephritis), in non-infectious inflammation (allergy, rheumatoid fever, collagenosis), in hepatic diseases, necrobiotic and neoplastic processes (malignant tumours, metastases of malignant tumours, infarct, TBC, syphilis), in dys- and paraproteinaemia, anaemia, leukaemia etc. Extremely high values of ESR (>80 mm/1st hour) may be observed in sepsis, autoaggressive diseases, plasmocytoma, renal failure or nephrotic syndrome, in rheumatoid diseases, thyroiditis etc.

Contrary, lower ESR may be found in polyglobulia, several allergic diseases, sickle-cell anaemia or cardiac insufficiency.

Material

Sterile syringe (2 ml), sterile injection needles, needs for venous blood taking, 3.8 % solution of sodium citrate, Westergren's pipettes with a stand (Fig.). *Westergren's pipette* is a graded glass tube divided in millimeters. The mark 200 is situated on the lower end of the tube and the mark 0 is in the distance of 200 mm on the top part. Pipette should be placed into the stand so that the lower part of the pipette is situated vertically in the plastic container (bowl) and fixed with a screw.

Methods

Under sterile conditions suck 0.4 ml of 3.8 % sodium citrate (anticoagulant) into 2 ml syringe. Fill the syringe up to 2 ml volume with venous blood from the cubital vein. Blow out the blood carefully from the syringe into the bowl. Press the pipette at the bottom of the screw and rotating the screw push the blood up to the mark 0. Start to measure the time.

Classical method of ESR evaluation

Let the pipettes with blood to stand in vertical position and precisely after 1 hour and 2 hours of investigation read the lower value of the plasma column. Write the result in the form: ESR = mm of plasma column after 1 hour / mm of plasma column after 2 hours of investigation (e.g. ESR = 6/10).

Accelerated method of ESR evaluation

Tilt the pipettes with blood into 45° angle using a stand for pipettes. After 15 minutes read a value of ESR, which is approximately corresponding with the value read after 1 hour of investigation by classical method.

Investigation of ESR must be performed in a room temperature!

Protocol

1. Write down the measured values in volunteers.
2. Write down the measured values separately in males and females, calculate mean values in both groups and compare the results.
3. What is the reason for higher ESR values in females?