

Teaching and Learning Medical Physiology

A SIMPLE METHOD FOR DEMONSTRATING SOME FACTORS AFFECTING ERYTHROCYTE SEDIMENTATION RATE

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Medical students are commonly given a practical demonstration as to how erythrocyte sedimentation rate (ESR) is determined. In our medical college, students are taught the Westergren and Wintrobe methods for determination of ESR. After filling the Westergren and Wintrobe tubes as required with anticoagulated blood they are kept undisturbed for one hour. Between setting the test up and the typical time at which the reading is taken, students are introduced to the concept of ESR. Besides the fact that the method was demonstrated, in the preceding years, the process of teaching students factors affecting ESR involved a theoretical discussion. Some students do have difficulty with some of the underlying concepts. With this in mind, a model that simulates some of the factors that affect ESR was used to demonstrate to our students some of the factors affecting ESR, and this is described below.

The concepts addressed using the model were:

1. Physical forces governing ESR

Red modeling clay available in the laboratory was used to make a model of red blood cells (RBC). We first measured equal portions of clay using an electronic physical balance. The weight of the modeled RBC ranged from 0.037 to 0.039 milligrams. These were then rolled by hand and shaped to simulate RBC (**Figure 1**). Twenty five to thirty such RBC were prepared a day prior to the actual demonstration. For demonstration we took a measuring cylinder (100 ml), labeled A. The cylinder was filled up to the 100 mark with liquid paraffin and this simulated normal plasma. There are two opposing physical forces i.e. a downward force created due to the downward movement of the RBC and an upward force due to displacement of the fluid around the settling RBCs, which determine the rate of RBC settling. In order to help students understand these forces, we picked up a model RBC using glass stirrers and dropped it very closely on the surface of the liquid paraffin in tube A (**Figure 2**). Students recorded their observations and also noted the time single RBC took to settle using a stopwatch. Students observed that for a second or two the RBC remained on the surface and then settled to the bottom of the tube at a steady rate. The total time from dropping the RBC to its settling at the bottom of the cylinder was 6 seconds and 63 milliseconds. Since the height of the liquid column was 100 mm the rate of fall of RBC is 15.08 millimeters per second. Since the specific gravity of liquid paraffin (simulating plasma) is less than that of

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our model of RBC, model RBC stay on the surface for only a second or two and then begin settling down. A downward force is created due to the downward movement of the RBC. The fall of the modeled RBCs causes an upward displacement of the medium, producing an upward current and a retarding force [1]. Normally there is a balance between these two forces and minimal settling occurs.

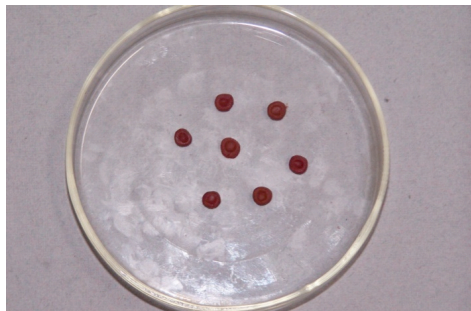


Figure 1: Clay model of RBC



Figure 2: Use of glass stirrers to drop RBC over liquid surface

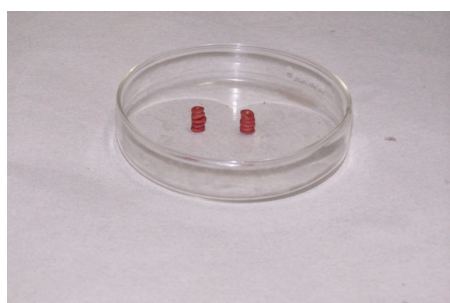


Figure 3: Clay model simulating rouleaux formation

2. Importance of rouleaux formation in determining ESR

Five **model** RBCs were stuck together with their flat surfaces facing each other so as to simulate a rouleaux (**Figure 3**). It was then dropped close to the surface of liquid paraffin with the help of a glass stirrer and the total time from dropping the rouleaux to settling was noted to be 1 second 56 milliseconds. This helped us demonstrate that the formation of rouleaux enhances ESR. The reason for this is that due to rouleaux formation, aggregates of large volume but relatively small surface area are produced, accelerating RBC sedimentation [1].

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3. Effect of plasma viscosity on ESR

Two additional measuring cylinders (100 ml each) were labeled B and C respectively. Cylinder B filled with glycerin diluted by 50% with water and cylinder C was filled with glycerin diluted by 20% with water. The solution in tube B simulated a decrease in plasma in relation to that in tube C. Rouleaux of an identical number of RBCs were dropped in each of these tubes at the same time and the sedimentation rate was noted in each. The settling time in tube B was 1 second 35 milliseconds and 9 seconds 10 milliseconds in tube C. This demonstrated the fact that reduction of plasma viscosity is one potential mechanism of an increase in ESR.

I wish to share this simulation with readers of the journal as I hope this might help students learn some of the factors affecting ESR more easily. I tried this with my class of 40 students and my overall impression was that they found it helpful.

Reference:

[1] Lee GR et al [ed.]. *Wintrobe's Clinical Hematology* (Volume 1), Lea & Febiger, Philadelphia / London, 1993, pp.16

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