

## Sedimentation Levels of Red Blood Cells (ESR) and its Effect on Viscosity of Blood Cells (PVC) and Glucose in Elderly People

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### Abstract

The erythrocyte sedimentation rate (ESR) is commonly used to assess the acute phase of the inflammatory response and to diagnose conditions associated with acute and chronic inflammation, including infections, cancers, and autoimmune diseases. Packed Cell Volume (PCV) is the height of the red cell column to the total height of the column of whole blood. This study included 100 healthy subject divided into two groups: females group (50) and males group (50). The increase in Erythrocyte Sedimentation Rate (E.S.R) was higher in women group than in men group. The result showed a negative correlation between the Packed Cell Volume (PCV) and ESR while there was a positive correlation between ESR with age and glucose.

Keywords: Erythrocyte Sedimentation Rate (ESR), Packed Cell Volume (PCV) and Glucose.

### Introduction

The erythrocyte sedimentation rate (ESR) is a simple and inexpensive laboratory test. It is commonly used to assess the acute phase of the inflammatory response and to help diagnose conditions associated with acute and chronic inflammation, including infections, cancers, and autoimmune diseases. ESR is nonspecific because the increase in its level do not tell exactly where is the inflammation site in the body or what is causing it, and also because it can be affected by other conditions besides inflammation. For this reason, ESR is typically used in conjunction with other tests [1]. The principle of the ESR is based on the fact that when well-mixed venous blood is placed in a vertical tube, the red blood cells (RBCs) will settle out of the plasma and fall towards the bottom of the tube and the pale yellow liquid (plasma) rises to the top. After 60 minutes, measurements are taken of the distance the red cells traveled to settle at the bottom of the tube. The length of the fall of the top of the column of red blood cells in a given interval of time is the erythrocyte sedimentation rate (ESR). Normally red cells don't settle far toward the bottom of the tube, they fall slowly, leaving little clear plasma. Many diseases make extra or abnormal proteins (such as fibrinogen or immunoglobulins, which are increased in inflammation) that cause the red cells to move close together, stack up, and form a column

(rouleaux). In a group, red cells are heavier and fall faster. The faster they fall, the further they settle, and the higher the ESR. [2] Erythrocyte sedimentation is affected by two major physiological factors: red cell surface charges and frictional forces around the red cell. The erythrocytes normally have net negative charges and, therefore, repel each other. High molecular weight proteins, especially when positively charged, increase viscosity and favor rouleaux formation and thus would raise the ESR. Rouleau is a condition in which the RBCs clump together like stacks of coins. As the stack increases, it becomes heavier and tends to fall to the bottom faster. Fibrinogen, the most abundant acute phase reactant, has the greatest effect on the elevation of ESR when compared with other acute phase proteins. Paraproteins are positively charged molecules and when abundantly present as in multiple myeloma or Waldenstrom's macroglobulinemia will increase the ESR levels by enhancing rouleaux formation and elevating plasma viscosity. On the other hand, a change in the frictional forces around the red blood cell can affect the ESR. Anemia causes a falsely increased ESR because the change in the RBC to plasma ratio decreases the frictional forces which favor rouleaux formation, causing the RBCs to fall quickly. With the hematocrit reduced, the velocity of the upward flow of plasma is altered so that red blood cell aggregates fall

faster. Macrocytosis with a small surface-to-volume ratio has charge relative to their mass and thus sediment more rapidly. [3]

Packed Cell Volume (PCV) is the height of the red cell column is measured and compared to the total height of the column of whole blood. The percentage of the total blood volume occupied by the red cell mass is the hematocrit. Hematocrit depends mostly on the number of RBCs but there is some effect (to a much lower extent) from the average size of the RBCs. The average error in hematocrit is about 1-2%. The hematocrit may be changed by altitude, position, and heavy smoking, in the same manner as the hemoglobin may be changed. The reference values are 42-52% for males and 36-48% for females, PCV is reduced in anemia, increased in erythrocytosis. [4].

**Subjects**

This study was performed during the period from June 2011 to November 2011. This study include one hundred apparently healthy subjects were admitted at Medical City Teaching Hospital and AL-Kazemia Hospital in Baghdad. Subjects were divided into two groups: group A include fifty male with age rang (55-69) years old, and group B fifty female with age rang (55-70) years old, were also included in this study.

**Blood collection and laboratory analysis**

From each subject, five ml venous blood was aspirated from a suitable vein. Samples were collected between (8-9A.M). To measure the ESR by E.S.R Winthrop method (1.6 ml of blood added to 0.4 ml of sodium citrate and mixed for two minutes and after that the tube is placed in Pipette E.S.R and comment in the rack for an hour then read the result, and packed cell volume (PCV) determined by centrifuging heparinized blood in a capillary tube at 10,000 rpm for five minutes. This separates the blood into layers. The volume of packed red blood cells divided by the total volume of the blood sample gives the PCV. PCV calculated by measuring the length of the blood layer. The haematocrit is slightly more accurate as the PCV includes small amounts of blood plasma trapped between the red cells. An estimated hematocrit as a percentage may

be derived by tripling the hemoglobin concentration in g/dL and dropping the units.

**Statistical Analysis**

Statistical analysis was performed by Excel 2007. Data analysis was done using chi- square test for tables with frequencies, while we used independent sample t-test for tables with means and standard deviations. P-value of  $\leq 0.05$  was used as the level of significance. Correlation coefficient used to find the correlation between the markers under study by using Pearson correlation. Descriptive statistics for the clinical and laboratory results were formulated as mean and standard error.

*Table (1)*

*Mean  $\pm$  SD of (Age, ESR, glucose and PCV) values of apparently healthy male and female groups.*

<i>Parameters</i>	<i>Females Mean <math>\pm</math>SD</i>	<i>Males Mean <math>\pm</math>SD</i>	<i>p-value</i>
Age (years)	<b>57.00<math>\pm</math>12.90</b>	<b>51.37<math>\pm</math>17.38</b>	<b>0.111</b>
ESR (mm/hr)	<b>30.23 <math>\pm</math> 6.2</b>	<b>22.6 <math>\pm</math> 6.708</b>	<b>P&lt; 0.05</b>
Glucose mg/dl	<b>91.67<math>\pm</math>23.09</b>	<b>98.05<math>\pm</math>19.77</b>	<b>0.251</b>
PCV %	<b>40.29<math>\pm</math>6.73</b>	<b>49.32 <math>\pm</math> 6.75</b>	<b>P&lt; 0.05</b>

*Table (2)*

*The correlation between ESR and parameters in studied groups.*

<i>parameters</i>	<i>Females group</i>	<i>Males group</i>
Glucose mg/dl	<b>0.392</b>	0.407
PCV %	<b>- 0.468</b>	- 0.491
Age years	0.332	0.489

## Results and Discussion

Table (1): Mean  $\pm$  SD of (Age, ESR, glucose and PCV) values of apparently healthy male and female groups.

The results revealed in Table (1) that there were an increase in ESR in female group more than that male. Female tend to have higher ESR values, as do the elderly. The higher values in fibrinogen levels of females correlated with sex differences. In women, the ESR is specifically influenced by the stage of the menstrual cycle. Obese people have also been noted to have slightly elevated ESRs, although this is not thought to have clinical significance. Anemia (PCV as indicator for anemia) and macrocytosis increase the ESR as in Table (2) there was negative correlation between ESR and PCV. In anemia, with the haematocrit reduced, the velocity of the upward flow of plasma is altered so that red blood cells sediment faster. Macrocytic red cells with a smaller surface-to-volume ratio also settle more rapidly. A decreased ESR is associated with a number of blood diseases in which red blood cells have an irregular or smaller shape that causes slower settling. In patients with polycythaemia, too many red blood cells decrease the compactness of the Rouleau network and artifactually lower the ESR [5]. An extreme elevation of the white blood cell count as observed in chronic myeloid leukemia has also been reported to lower the ESR. Hypofibrinogenemia, hypergammaglobulinemia associated with dysproteinemia, and hyperviscosity may cause a marked decrease in the ESR. Although, it has been reported that drug therapy with aspirin or other nonsteroidal anti-inflammatory agents may decrease the ESR, this has been disputed. Precaution must be taken when performing ESR to avoid factors that may produce erroneous values [5].

As shown in Table (2) there was positive correlation between the ESR and glucose. The striking of many markers of inflammation has been associated with insulin resistance or diabetes, raising questions about the specificity of the associations. Furthermore, there were evidence that acute phase reactants directly affect cellular processes that lead to insulin resistance and glucose. An additional difficulty in attributing a causal role to acute phase

reactants is that other disease processes can lead to elevations in the concentrations of these substances. In addition, people with diabetes are at increased risk of developing infections that can also raise concentrations of pro-inflammatory cytokines and acute phase reactants [6]. Several lines of research are providing insights into the role of inflammation in the pathophysiology of diabetes. Various insults, including free radicals and cytokines (such as tumor necrosis factor- $\alpha$  and interleukin-1), can disturb normal endothelial functioning. This disturbance in turn can impair insulin-mediated vasodilatation, resulting in delays in transendothelial insulin transport, reduced glucose disposal, and eventually insulin resistance [7]. Furthermore, the inflammatory process produces reactive oxygen species that injure pancreatic- $\beta$  cells, which are characterized by poor intracellular antioxidant defenses and are susceptible to oxidative damage. Free radicals have been shown to disrupt insulin action and total body glucose disposal [8].

## Conclusions

There were an increase in glucose level with an increased ESR level. The increase in ESR level with an increased in glucose level may indicate the began of insulin resistance or diabetes mellitus if the reason of increase in ESR is not treated. also There were an increases ESR level in female group more than the male. Female tend to have higher ESR values, as do the elderly. The higher values in females correlate with sex differences in fibrinogen levels. In women, the ESR is specifically influenced by the stage of the menstrual cycle. Obese people have also been noted to have slightly elevated ESR.

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طردية بين سرعة ترسيب كريات الدم الحمراء مع العمر ومستوى الكلوكون في الدم.

#### الخلاصة

معدل ترسيب كريات الدم: يستعمل لقياس استجابة الجسم في حالة الالتهاب للمساعدة في تشخيص الامراض المرتبطة بالالتهابات الحادة و المزمنة وتشمل هذه الامراض (العدوى والسرطان و امراض المناعة الذاتية). حجم الخلايا المضغوطة: هو ارتفاع مستوى كريات الدم الحمراء في الانبوب الشعري ويقاس بالمقارنة مع الارتفاع الكلي للعامود. تضمنت الدراسة ١٠٠ نموذج تم تقسيمها الى مجموعتين:- مجموعة النساء وتضمنت ٥٠ نموذج ومجموعة الرجال وتضمنت ٥٠ نموذج لتحري التغير في مستويات معدل سرعة ترسب كريات الدم الحمراء وحجم الخلايا المضغوطة للدم بين النساء والرجال مع التقدم في العمر. حيث اظهرت النتائج ان معدل زيادة سرعة ترسيب كريات الدم الحمراء كانت اكثر عند النساء، كما اظهرت النتائج علاقه عكسية بين حجم الخلايا المضغوطة مع معدل ترسيب كريات الدم بينما هنالك علاقه